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# Operation

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## Foreword

It is not enough to credit the Los Angeles Fire Department with the conduct of these tests and the preparation of this report. Due also is the grateful acknowledgment of a major contribution to the cause of life safety from fire. We believe that this contribution has far-reaching significance and offers new information of special importance to all concerned with life safety in schools and other places of public assembly.

In behalf of the members and friends of the National Fire Protection Association, I take this opportunity to express gratitude to Chief Engineer William L. Miller and to his Los Angeles Fire Department for this major contribution to the technology of life safety from fire.

Percy Bugbee  
*General Manager*

NATIONAL FIRE PROTECTION ASSOCIATION



# Operation School Burning

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# Operation School Burning

By the Los Angeles Fire Department

## Part I

### Brief Historical Background of Tests

As a result of the tragic fire at the Our Lady of the Angels School, Chicago, Illinois, on December 1, 1958, in which 95 pupils and teachers died, intensive inspections of the Los Angeles schools were made. During those inspections it was learned that a three-story section of the Robert Louis Stevenson Junior High School was to be demolished. Before demolition was scheduled to start, the Los Angeles Board of Education offered the building to the Los Angeles Fire Department for the purpose of conducting these fire tests. Contact was made with the Educational Facilities Laboratories, an organization estab-

lished by the Ford Foundation, which agreed to finance the tests

The tests discussed in this report were conducted under the direction of Raymond M. Hill, Fire Marshal, City of Los Angeles. Mr. Norman J. Thompson (formerly Director, Factory Mutual Laboratories, Norwood, Massachusetts), served as a technical consultant. John G. Degenkolb, Battalion Chief, Los Angeles Fire Department, served as Assistant Director in charge of procuring material and preparation of the test building. Leo K. Najarian, Acting Battalion Chief, Los Angeles Fire Department, served as Assistant Director in charge of instrumentation and recording of data.



Figure 1. Front exterior view of the Robert Louis Stevenson Junior High School, Los Angeles, Calif. Section used for test purposes is at the rear.

Prior to the tests a meeting of an Advisory Committee, hereinafter named in the acknowledgments, was held to discuss various types of protection to be tested and the manner in which the tests should be conducted. Following this initial meeting the Advisory Committee was discharged.

### **Purpose of Tests**

The purpose of these tests was to investigate methods of protecting multistory, open stairway school buildings, whether new or existing, to provide a safe environment for occupants under fire conditions.

The enclosure of stairways in buildings has long been a recognized means to protect the lives of occupants by minimizing fire and smoke spread. However, fire protection authorities are continually confronted with the practically insurmountable problem of having doors blocked open at stairway openings. Also in school buildings many school administrators and others object to closed doors on stairway enclosures because they may interfere with the safe and free passage of students between classes.

These facts established the ultimate purpose and scope of these fire tests.

### **Scope and Nature of Tests**

The tests included studies of the effectiveness of curtain boards (draft or fire curtains) at stairway openings and in corridors, roof vents over stairways, and complete and partial automatic sprinkler protection, individually and in combination. Data were also tabulated on the operation of automatic fire and smoke detection equipment, fusible links, and automatic door closers.

Fires were built at the bottom of one of the open stairways, in classrooms, and in corridors.

Conditions existing in the building during the tests were recorded by observers, from test equipment, and by instruments. Conditions recorded included temperature, pressure, and smoke density. The functioning of the fire protection equipment utilized during each test was also recorded.

The effectiveness of each type of protection installed was evaluated from the data recorded and by the judgment of observers in the building during each of the tests.

Tests were varied to simulate conditions that could exist in an operating school in winter months, summer months, and when occupants are notified of fire in the building.

Since the stairs and balustrades were solid, a 4-foot hole was made in both stairways to provide a clear vertical flue through the stairways after the initial tests raised a question in the minds of the observers as to whether such a clear flue would alter the results derived up to that time. This alteration was made in one stairway for the tests conducted after May 18, 1959, in both stairways after May 20, 1959.

The fire tests were grouped in the following Series, bearing on the protection or devices being studied:

**Series A:** Basic tests with no protection to establish criteria and to simulate conditions existing in summer, in winter, and with test fires in the locations used in the other Series.

**Series B:** Tests using a roof vent at the top of one of the open stairways.

**Series C:** Tests involving the installation of automatic sprinklers as the only means of protection.

**Series D:** Tests of the effectiveness of roof vents over stairways and automatic sprinklers.

**Series E:** Tests of the effectiveness of roof vents over stairways and curtain boards (draft or fire curtains) at stairway openings and in corridors under simulated winter conditions and with the test fires at the base of an open stairway

**Series F:** Tests of the effectiveness of roof vents over stairways and curtain boards (draft or fire curtains) at stairway openings and in corridors under simulated summer conditions and with conditions that would exist if the building were occupied and occupants were notified of fire. The test fires were at the base of an open stairway.

**Series G:** Tests of the effectiveness of roof vents over stairways and curtain boards (draft or fire curtains) at stairway openings or in corridors and with the test fires in classrooms.

**Series H:** Tests of the effectiveness of roof vents over stairways and curtain boards (draft or fire curtains) at stairway openings and in corridors and with the test fires in corridors.

**Series I:** Tests of the effectiveness of curtain boards (draft or fire curtains) in corridors, and with one roof vent over a stairway equipped with a water aspirator to induce draft. All the test fires were started at the base of the open stairway equipped with the forced draft vent

**Series J:** Tests of the effectiveness of combinations of roof vents over stairways, curtain boards (draft or fire curtains) at stairway openings and in corridors, and with automatic sprinklers. The test fires were at the base of an open stairway

**Series K:** Tests of the effectiveness of a water aspirator in a roof vent

over one stairway, curtain boards (draft or fire curtains) in corridors, and with automatic sprinklers

**Series L:** Three tests to study the flame spread characteristics of "slow burning" cellulose fiber acoustical tile, both painted with an Underwriters' Laboratories listed fire retardant paint and unpainted. These tests were not originally scheduled and were conducted because early in the testing program the existing tile in the first floor corridor ignited and burned vigorously.

### Limitations of Tests

The tests reported herein were conducted in a building involving a specific type of construction and with open stairways. The test fires, while believed to be representative of the type of fire which might occur in a school, involved ordinary combustible materials and were planned and built to produce conditions most desirable for these tests

The fire protection equipment utilized in these tests was installed with the purpose of the tests in mind and not necessarily in a way or under conditions satisfactory to the best operation of the equipment.

These and other limiting features should be remembered by those studying the results of these tests. Conditions other than those specified in this report could produce somewhat different results

Certain basic fundamentals and conclusions derived from these tests point to the need for re-evaluating some current provisions for life safety in existing codes and standards and for further tests to establish more information of a basic nature on which future recommendations on life safety from fire may be derived.

## Sponsoring Agencies

These tests were jointly sponsored by the four agencies listed below.

### The Los Angeles Fire Department

The Fire Department inaugurated the test program, conducted the tests, and provided the necessary manpower

### Los Angeles Board of Education

The Board of Education supplied the building, grounds, utilities, blue-printing, photostating, and drafting services. Dr. Schuyler Joyner, Business Manager of the Board, also performed liaison services with the Educational Facilities Laboratories. Kenyon Smith, Principal of the Robert Louis Stevenson Junior High School, and his Staff represented the Board of Education on the premises.

### Educational Facilities Laboratories, Inc.

The Educational Facilities Laboratories, Inc., a separate corporation established by the Ford Foundation to help schools and colleges with their physical problems, were represented by Harold B. Gores, and provided financial assistance which was necessary in order to conduct the test program.

### Office of the Fire Marshal of the State of California

Joe R. Yockers, the State Fire Marshal, and Louis Segal, Chemist for the Fire Marshal, gave technical and professional assistance and advice.

## Preparation of the Report

This report was jointly prepared by the Los Angeles Fire Department and the staff of the National Fire Protection Association.

Test results were studied and evaluated by a committee consisting of

Raymond M. Hill, Chairman, Los Angeles Fire Department

John G. Degenkolb, Los Angeles Fire Department

Leo K. Najarian, Los Angeles Fire Department

Louis Segal, California State Fire Marshal's Office

Richard E. Stevens, National Fire Protection Association

Norman J. Thompson, Technical Consultant

Joe R. Yockers, California State Fire Marshal

## Acknowledgments

The following individuals and organizations contributed to the conduct of these tests and are listed herein for a permanent record of their contribution

### Advisory Committee

The following persons served on the Advisory Committee

Craig C. Chandler U. S. Forest Service  
John G. Degenkolb Los Angeles Fire Department

J. F. Ernst National Automatic Sprinkler & Fire Control Association

A. B. Everts U. S. Forest Service  
Don T. Hibbard Los Angeles Fire Department

Raymond M. Hill Los Angeles Fire Department

Clyde Koskinan Underwriters' Laboratories, Inc.

Leon M. Laskowski Minneapolis-Honeywell Regulator Co.

William L. Miller Chief Engineer, Los Angeles Fire Department

Louis Segal Office of California State Fire Marshal

L Eugene Stanley	Minneapolis-Honeywell Regulator Co
A. J Steiner	Underwriters' Laboratories, Inc
N J Thompson	Technical Consultant
R. L Thorsdale, Jr	National Automatic Sprinkler & Fire Control Association
Prof George Troxell	University of California
Carl Wilson	U S. Forest Service
Joe R Yockers	California State Fire Marshal

### Major Contributors

The following made major contributions to the test program:

**NATIONAL FIRE PROTECTION ASSOCIATION.** The NFPA was represented by Richard E. Stevens, who performed considerable research concerning the fire problem and evaluation of the data, and supervised the preparation of the report.

**NATIONAL AUTOMATIC SPRINKLER AND FIRE CONTROL ASSOCIATION.** This Association furnished and installed the necessary automatic sprinkler equipment, maintained the sprinkler equipment in an operating condition throughout the tests, and made the necessary replacement and alterations to accomplish various fire tests

**AMERICAN DISTRICT TELEGRAPH COMPANY.** This Company provided the smoke detection instrumentation, the personnel and equipment for the measurement of smoke densities, installed and maintained the fire alarm equipment, and provided an intercommunication system to assist in the conduct of the tests.

**MINNEAPOLIS-HONEYWELL REGULATOR COMPANY.** This Company provided the instrumentation necessary for recording temperature data from the tests and also installed fire detection equipment as was necessary for certain phases of the test program.

### Other Contributors

In addition to the above, the following organizations made contributions of materials and labor as were necessary for the conduct of the tests

American Broadcasting Co., American Iron & Steel Institute; Albi Manufacturing Co., Inc., Baltimore Paint & Chemical Corp., Barnard Chemical Co., J. H. Baxter & Co., Bureau of Water & Power, City of Los Angeles; Callaway Co; Chapco Engineering Co., Coast Insulating Co, Colt Ventilation of America, Inc., Columbia Paint & Varnish Co, Combined Steel Industry; Desilu Productions, Inc., Donaldson Power Ventilating Co.; Douglas Fir Plywood Association, Edwards Co., Inc, Fire Foundation, Inc., Gladding, McBean Co., Gypsum Association, Insulation Board Institute; Kimberly-Clark Corp.; Lahabralite Co., Lathing Institute of So. California, Los Angeles City Health Dept., Los Angeles School Building Contractors Association, Morse Signal Devices; National Lumber Manufacturers Association, Norton Door Closer Co., Notifier Fire Alarm, Inc.; Ocean Chemical Co., Overly Door Co; Owens-Corning Fiberglas Corp., Paramount Pictures Corp.; Protection Engineering Corp.; Pyrotronics; Schlage Lock Co.; Simpson Logging Co.; Southern California Gas Co., Special Effects Manufacturing Co., Tele-Fire of California, The Structural Steel Workers Local 433, Union Oil Company of California, U S. Plywood Corp.; Ventilouvre Company-Kenneth Courtney, Inc; Wasco Products, Inc.; West Coast Lumbermen's Assn.

## Part II

### The Test Building

The Robert Louis Stevenson Junior High School was built in 1925. The portion of the structure used for the fire tests discussed in this report was a 90-foot section of the building. The following description pertains only to that portion of the building used for the fire tests.

During the testing program, fire damaged transoms, doors, plaster on ceilings, and other minor parts of the building. This damage was repaired between tests or as necessary.

### Main Structure

HEIGHT. 3-story, partial basement

FOUNDATION: Reinforced concrete

EXTERIOR WALLS: Brick, bearing, 17 inches thick to second floor level, 13 inches above.

COLUMNS AND GIRDERS Reinforced concrete

ROOF: Rafters and ceiling joists 2- by 6-inch wood, 24 inches on center trussed together, rafters decked with wood and covered with asphalt paper, tar and gravel

FLOOR FRAMING (EXCEPT CORRIDORS): 2- by 16-inch wood, 12 inches on center on first and second floors.

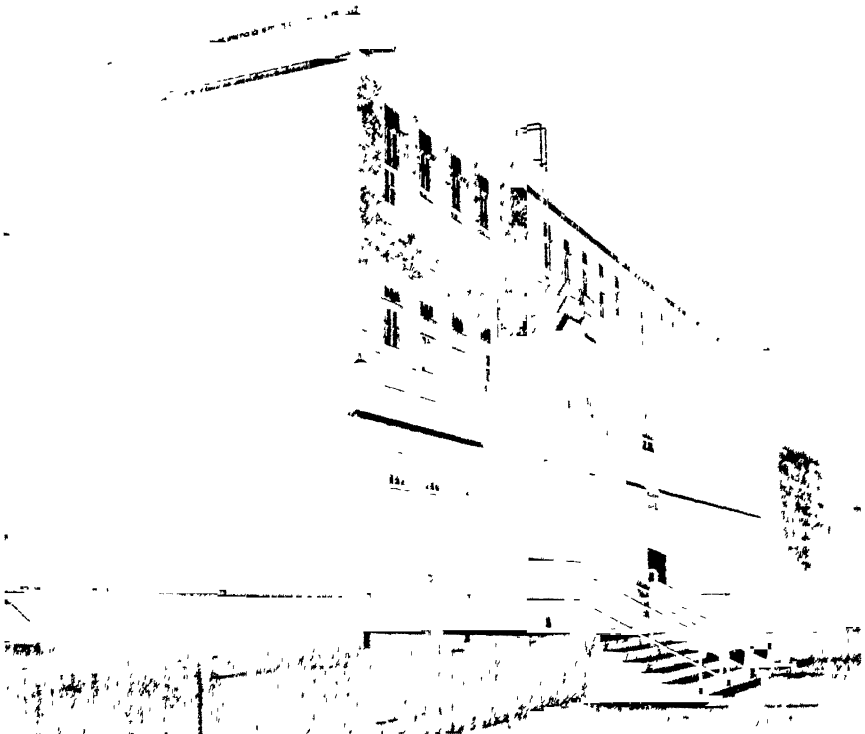


Figure 2. An exterior view of the three-story section of the school used for the tests.

## Classrooms

HEIGHT 12 feet

CORRIDOR WALLS Plastered 6-inch hollow tile.

PARTITIONS BETWEEN CLASSROOMS. Metal lath and plaster on wood studs

CEILINGS Metal lath and plaster on wood joists

FLOORS Tongue and grooved maple

TRIM: Wood

DOORS: Wood panelled (5 panels),  $1\frac{3}{4}$ -inch, 3 feet by 7 feet, second panel from top replaced with three panes of wired glass

TRANSOMS. Over each door,  $1\frac{1}{8}$ -inch, 3 feet by 2 feet 5 inches, three panes of clear glass in each Hinged at bottom, opened into classrooms Two transoms spaced between doors as shown in Figure 10, same size and construction.

## Corridors

HEIGHTS: First floor, 12 feet, 11 inches  
Second floor, 12 feet, 11 inches  
Third floor, 12 feet

WALLS Plastered 6-inch hollow tile Metal lockers, standpipe hose cabinets and drinking fountains set in walls

TRIM: Wood.

CEILINGS: First and second floors reinforced concrete, finished with 12-inch by 12-inch cellulose fiber perforated acoustical tile cemented to concrete \* Third floor, metal lath and plaster on wood joists finished with 12-inch by 12-inch cellulose fiber perforated acoustical tile cemented to plaster.

## Stairways

WALLS: No. 1 — West, exterior wall.  
East, 17-inch brick first story, 13-inch brick above  
No. 2 — West, 17-inch brick first story, 13-inch brick above.  
East, plastered 6-inch hollow tile.

FLOORS (LANDINGS):  $6\frac{1}{2}$ -inch reinforced concrete.

STAIRS Reinforced concrete.

TRIM Wood.

BALUSTRADE. 3-inch reinforced concrete, plastered and with wood cap and wood handrail.

NOTE: The solid stairs and balustrades in this building resulted in a circuitous path of travel for smoke and heat Because some stairways are constructed with a continuous open flue at the center of the shaft, a 4-foot diameter hole was cut in the stairs as shown in Figure 3 to simulate this type of construction. Tests conducted on May 19 were with a hole in stairway No. 2 All tests after that date were with a hole in both stairways.



Figure 3. A photograph of the 4-foot diameter hole cut in stairway No. 2.

## Separating Partition

A steel-frame, metal-lath, and plaster partition was installed in each corridor at each floor level to separate the portion of the building used for test purposes from the remainder of the structure. A solid core wood door and three wired-glass observation windows were placed in each partition.

\*The tile on the ceiling of the first floor corridor burned out during the first test and was not replaced except during Series L.

## Instrumentation

A level of 5 feet above the floor for the location of thermocouples and photoelectric cells was selected as an average head height of school children

### Thermocouples

Each corridor contained six thermocouples (see Figure 10), three located 8 inches from the ceiling and three, 5 feet from the floor. Additional thermocouples were located at the ceiling above the second floor landing, at the roof vent in both stairways, and at the ceiling above the landing between the basement and first floor of stairway No. 2. The wires to the last-mentioned thermocouple were used whenever an extra thermocouple was added for the test fires in classrooms. During tests involving sprinklers, thermocouples near sprinklers were protected from possible exposure to water discharge by cans placed over them.

Two recording instruments were located in the Instrument room on the second floor one recorder cycled once every 16 seconds, the other, once every 32 seconds.

### Photoelectric Cells

The American District Telegraph Company (ADT) installed two light sources and two corresponding photoelectric cells in each corridor (see Figure 10). The light beam from each source penetrated the width of the corridor and was reflected by a mirror back to a photoelectric cell installed adjacent to the source. The light beam was about 5 feet from the floor. Current flow (microamperes) through photoelectric cells was measured at  $\frac{1}{2}$ -minute intervals throughout the tests.

### Manometers

Three manometers, one in each corridor, were installed in the temporary partition separating the test structure from the remainder of the building. The manometers were of the inclined tube type calibrated at 1/100-inch water pressure for each graduation. Readings were taken each minute during tests.

## Fire Protection Equipment

### Automatic Sprinklers

Sprinklers used in these tests were upright,  $\frac{1}{2}$ -inch orifice, rated at 165 degrees Fahrenheit and spaced as recommended in the NFPA Standard for Sprinkler Systems (No. 13) for light hazard occupancies, except for sprinklers placed in openings to stairways when the objective was to provide a water curtain. Sprinklers were located as shown in Figure 11. The sprinkler system was supplied by a pumper taking suction from a street hydrant and through a 4-inch alarm valve with a retard chamber and circuit closer. Static pressure at the sprinklers in the third floor corridor was 40 pounds per square inch.

### Vents

The roof vent openings at the top of each stairshaft were 63 square feet. Each opening was covered with six sheet metal panels, each  $10\frac{1}{2}$  square feet in area. Vent openings up to 63 square feet in  $10\frac{1}{2}$  square foot increments could thus be provided. Operation by fusible link was simulated by a bucket suspended by wire from a fusible link located in the vent opening. When the bucket fell, the panels were removed manually. Vents were opened manually on notification by an audible signal device when operated by other than fusible links.

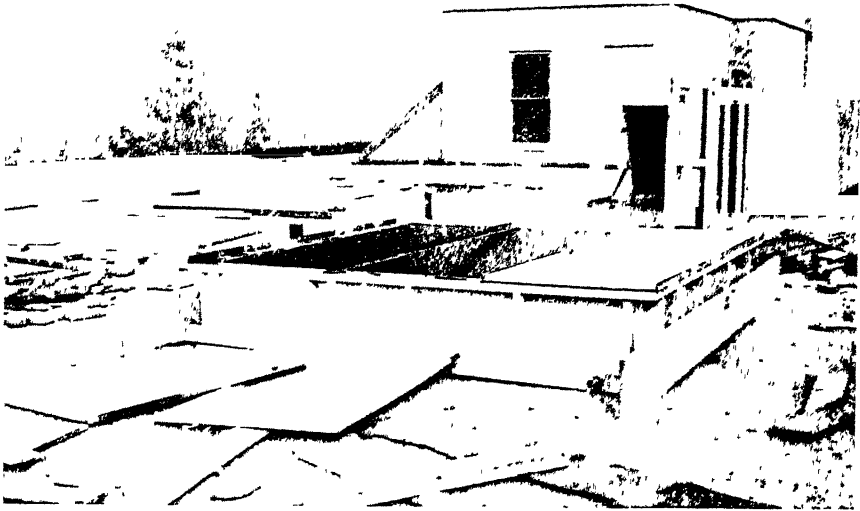


Figure 4. A view of the vent opening over stairway No. 2 showing the removable panels that permitted varying the vent area up to 63 square feet.

#### Curtain Boards (Draft or Fire Curtains)

Curtain boards were constructed of wood frame covered with gypsum wallboard. Boards were located in corridors and stairway openings as shown in Figure 10 and installed down to a level of 7 feet above the floor



Figure 5. A curtain board installed in the opening to stairway No. 2 at the first floor level.

#### Fusible Links

Fusible links listed by Underwriters' Laboratories, Inc., and rated at 135 and 160-165 degrees Fahrenheit were used. Although the links were not loaded to the extent as is done when tested for listing, it was estimated that the links were weighted sufficiently to overcome any difference in time of operation that could occur.

#### Door Closers

Automatic door closers with hold-open arm embodying a fusible link release, listed by Underwriters' Laboratories, Inc., were used. The fusible link releases were rated to operate at 135 degrees Fahrenheit and 160-165 degrees Fahrenheit.

#### Automatic Fire Detection

The automatic fire detection equipment used was of the pneumatic tube rate-of-rise type. The tubing was installed in locations shown in Figure 12. Note that the pneumatic tubing was strategically located and the significant results in individual tests are



Figure 6. A typical curtain board installation in a corridor. The can hanging at the left houses one of the thermocouples, shielding it from sprinkler discharge.

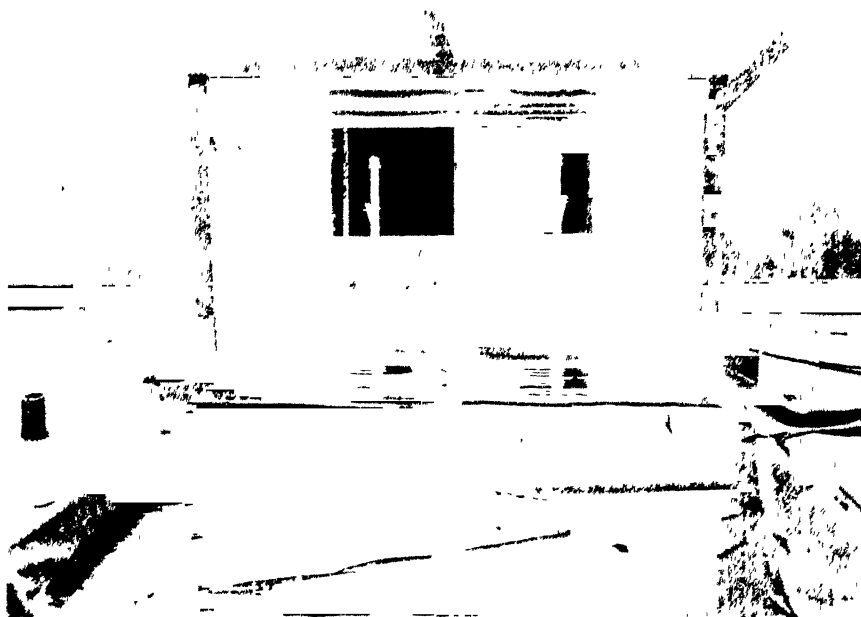


Figure 7. View of the aspirator in the vent opening above stairway No. 2 showing the enclosure with the back open to produce a venturi action.



Figure 8. An observer noting smoke conditions in one of the corridors. Note the smoke curling under the curtain board.

tabulated. The tubing was directly over the test fire in only one case as indicated in the individual test analysis.

#### Smoke Detection System

In three tests a smoke detection system of the photoelectric cell type was used to detect the test fire. The light source and receiver were installed in stairway No. 2 at the basement level just above the test fire location (see Figure 12).

#### Aspirator

In some of the tests, an attempt was made to improve venting facilities by the installation of four 60-degree water spray nozzles above the vent opening at the top of stairway No. 2 (see Figure No. 7). The nozzles used were  $\frac{1}{2}$ -inch orifice with approximately the same discharge characteristics as a standard sprinkler head.

Static pressure at the nozzles was 36 pounds per square inch.

A wooden enclosure was built over the nozzles and opened only at the nozzle discharge side. In some of the later tests, the back of the enclosure was opened in an attempt to produce a venturi action.

#### Observers

Six men were stationed in the corridors, one at each end, two on each floor, to record conditions during the tests and to note the time at which these conditions existed. Such things as smoke conditions, operation of sprinklers, opening of vents, operation of door closers and similar items were recorded, together with the effect the fire protection equipment had on tenability conditions in the building.

These data were correlated with that collected in the instrument room.

## Test Fire

All test fires were in wood pallets, each roughly 4 feet by 5 feet, constructed of well-seasoned boards nailed to 2-inch by 4-inch wood, generally with space between the boards. The majority of the fires involved 1,400 pounds of pallets

Pallets were stacked and in some tests only solid pallets were used, the space between boards having been covered with boards nailed over the spaces

The pallets were ignited with two cotton and gauze torches soaked in a high flash point thinner.

On the basis of an average calorific value of the wood used in the test fires of 8,000 Btu per pound and complete combustion of the wood in 30 minutes, the following average rates of heat emission may be considered as being dissipated from the various sizes of test fires used.

This type of test fire was selected because it resulted in a moderately fast developing fire. It involved a fire load of about one-third of what might be expected in an average classroom of a school; however, the fire load in a classroom would be spread over a much larger area than the test fire



Figure 9. A typical pallet arrangement for a test fire at the base of stairway No. 2.

used. The test fire also produced realistic quantities of smoke typical of the amount generated from fires in ordinary combustible materials.

At least one hour elapsed between tests conducted on the same day to allow the building to cool sufficiently so that ambient temperatures were roughly the same at the start of each test

Test fires were extinguished with hose streams at the end of each test

<u>Pounds of Fuel</u>	<u>Total Calorific Value Btu</u>	<u>Average Heat Release Btu per Minute</u>	<u>Maximum Average Heat Release Btu per Minute (Estimated)*</u>
350	2,800,000	93,400	140,000
500	4,000,000	133,000	200,000
700	5,600,000	187,000	280,000
1,400	11,200,000	374,000	560,000
2,000	16,000,000	534,000	800,000

\*It was estimated that about 75 per cent of the wood pallets were burned in a 20-minute period. Of this, about 66 per cent (or 50 per cent of the total) were burned in the period between 5 and 15 minutes from the start of the fire.

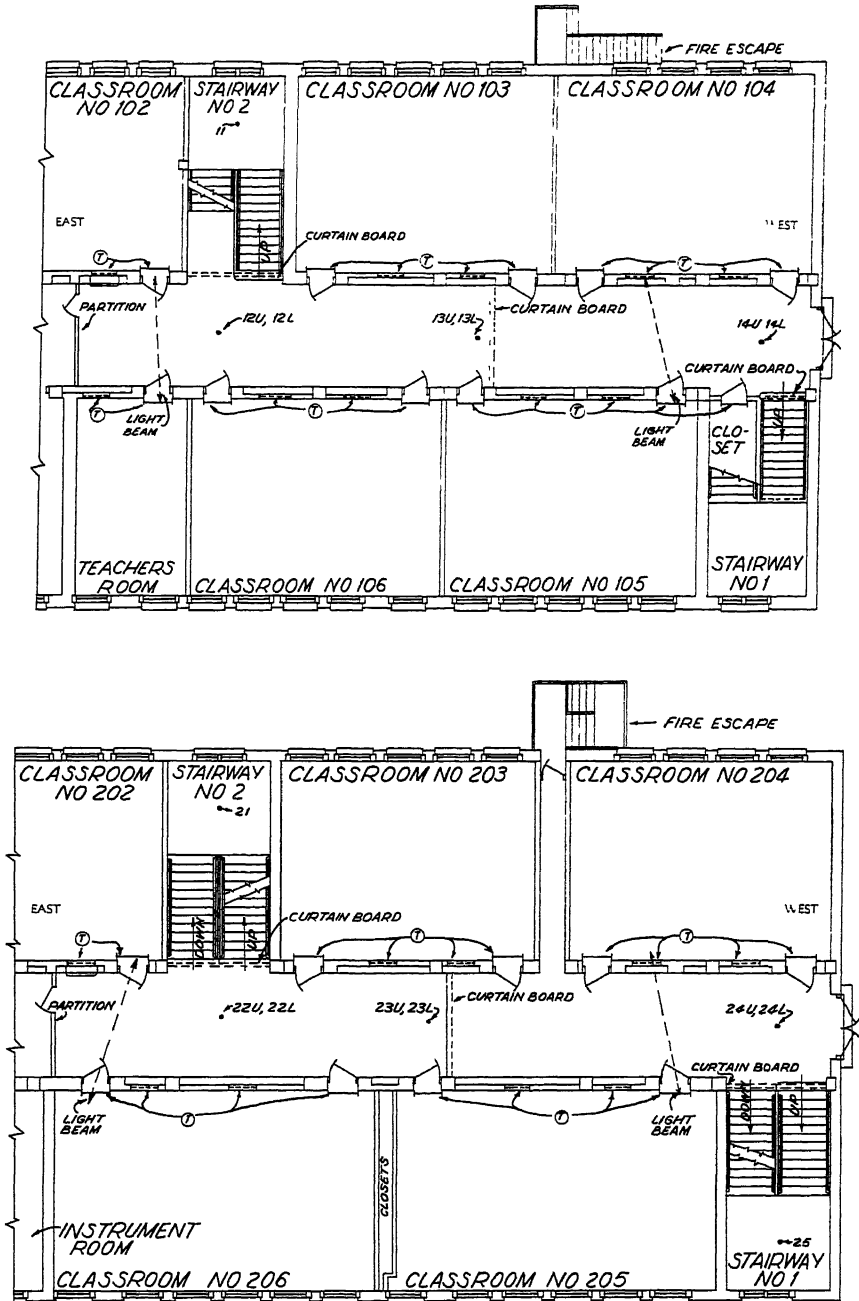


Figure 10. Floor plans of first (upper drawing) and second floors showing location of thermocouples, curtain boards and light beams from photoelectric cells.

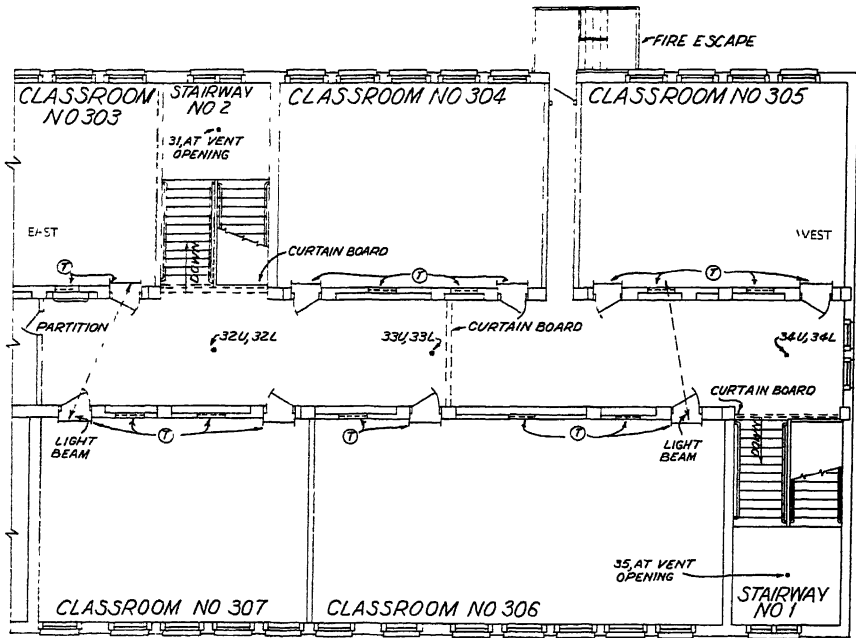


Figure 10 Cont. Floor plan of third floor showing location of thermocouples, curtain boards and light beams from photoelectric cells.

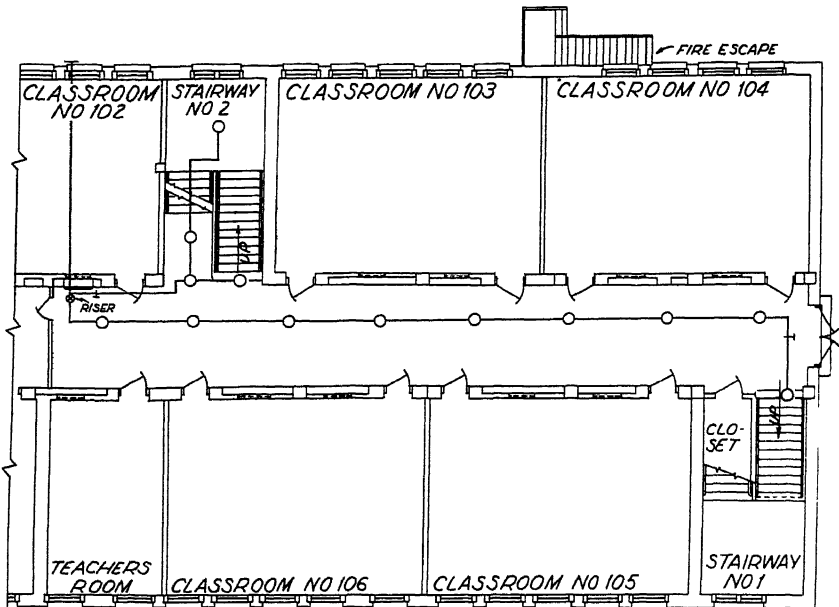


Figure 11. Floor plan of first floor showing location of automatic sprinklers.

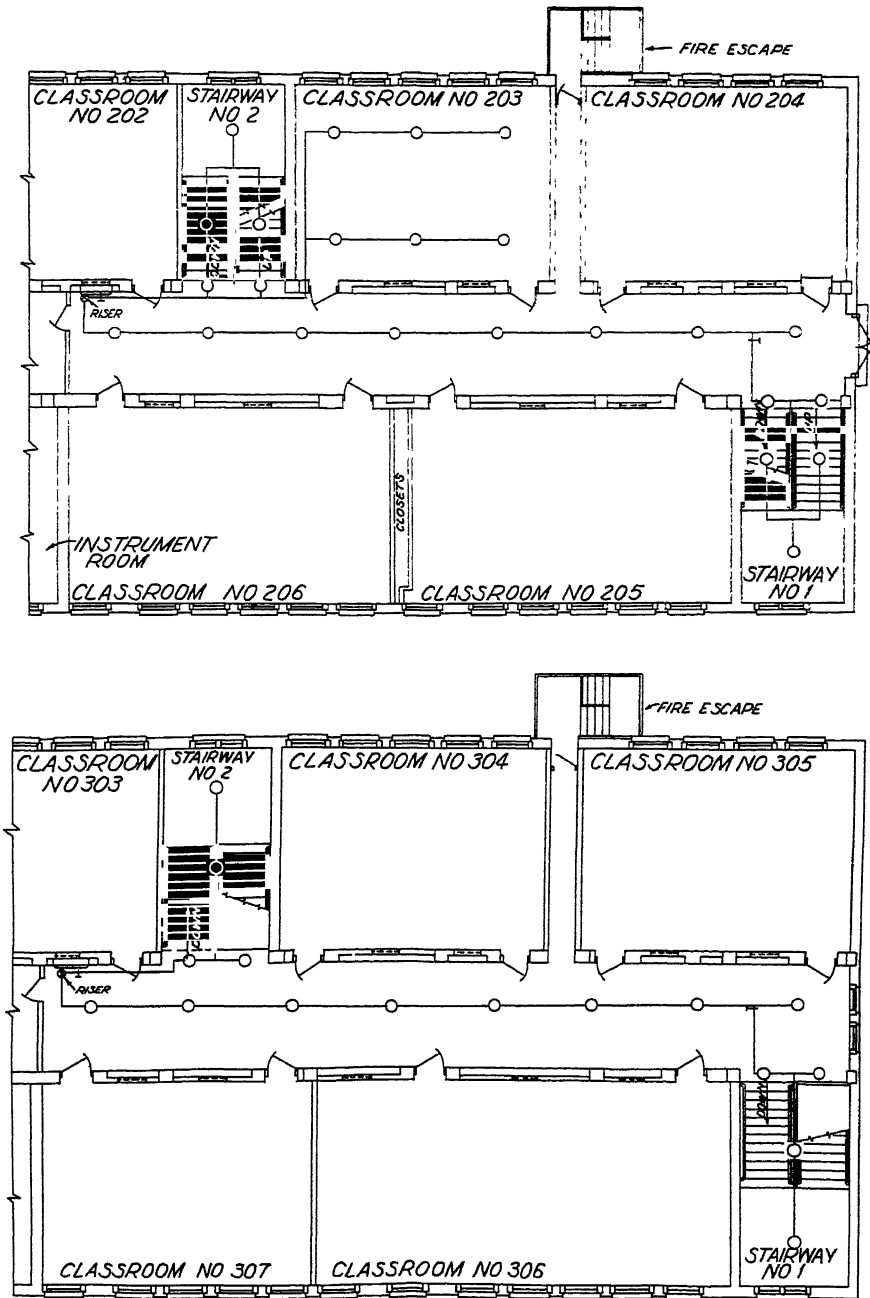


Figure 11 Cont. Floor plans of second (upper drawing) and third floors showing location of automatic sprinklers.

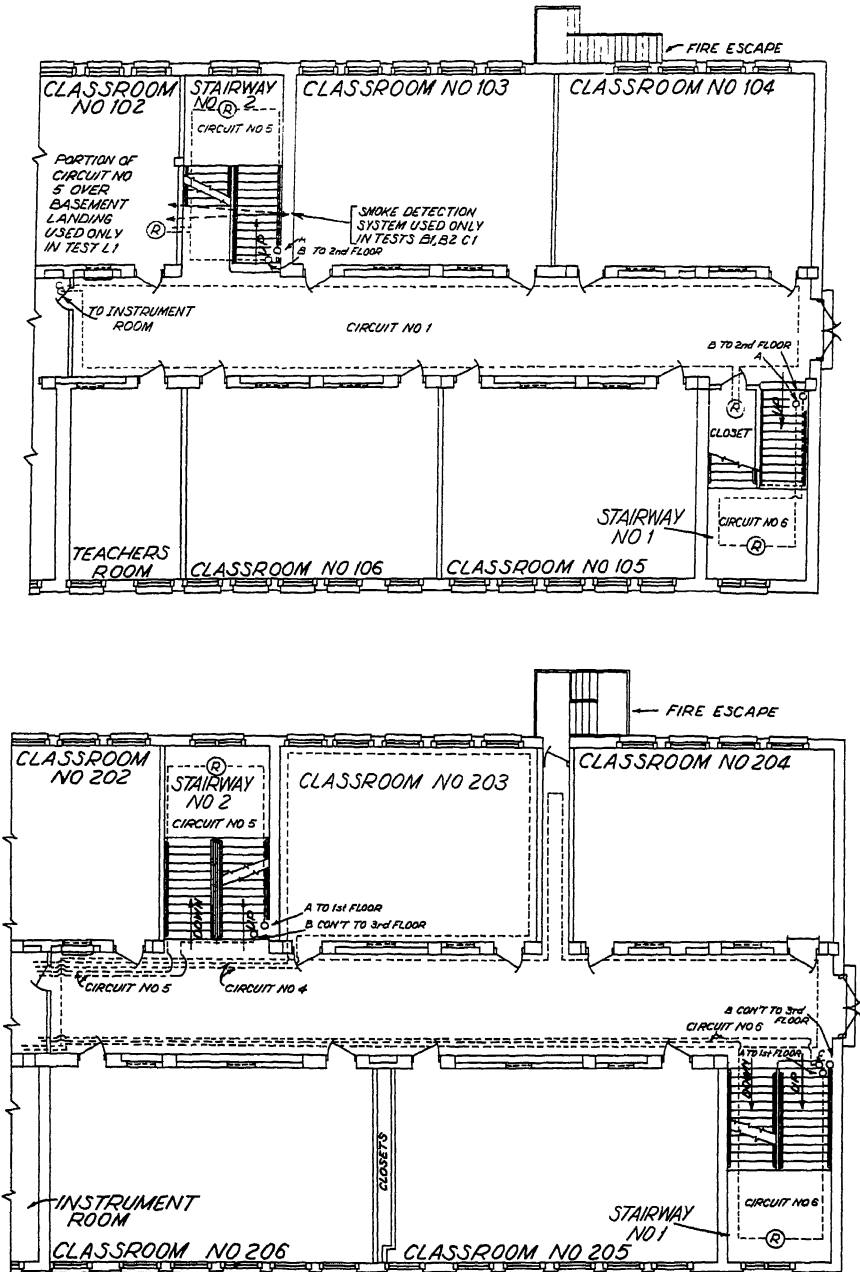


Figure 12. Floor plans of first (upper drawing) and second floors showing location of pneumatic tubing of rate-of-rise automatic fire detection system.

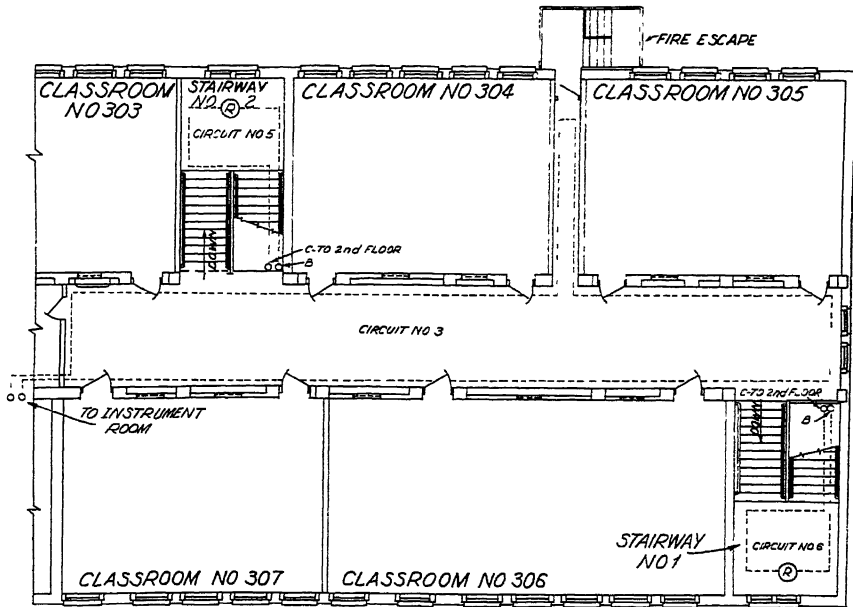


Figure 12 Cont. Third floor plan showing location of pneumatic tubing of rate-of-rise automatic fire detection system.

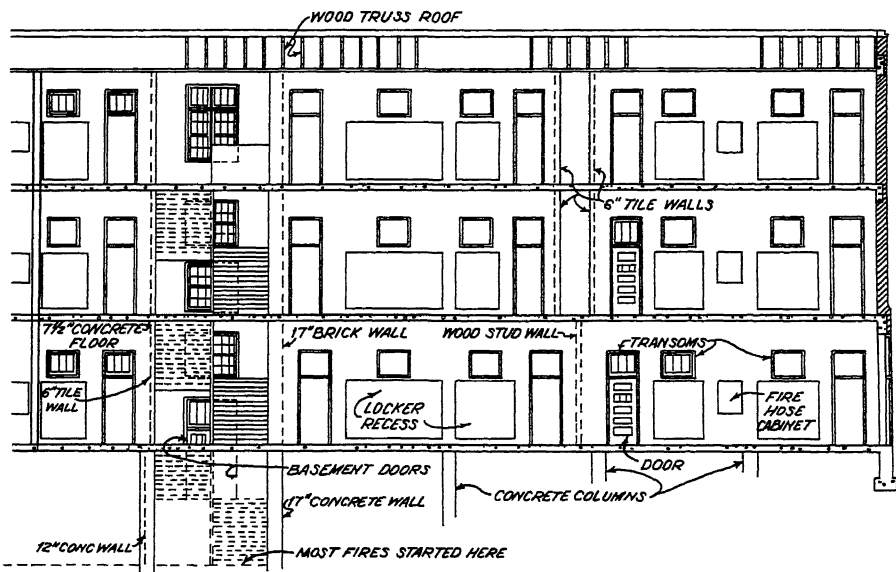


Figure 13. Longitudinal section through test building.

### Abbreviations Used in Drawings and Graphs

Thermocouple locations are designated by a number, and where applicable followed by U or L indicating upper (8 inches from ceiling) or lower (5 feet from floor)

Automatic sprinkler heads are designated by A S or by a circle

T indicates transom.

1E, 1W, 2E, etc, indicates first floor, east end, first floor, west end, second floor, east end, etc.

T indicates a valve

R indicates rate-of-rise detector

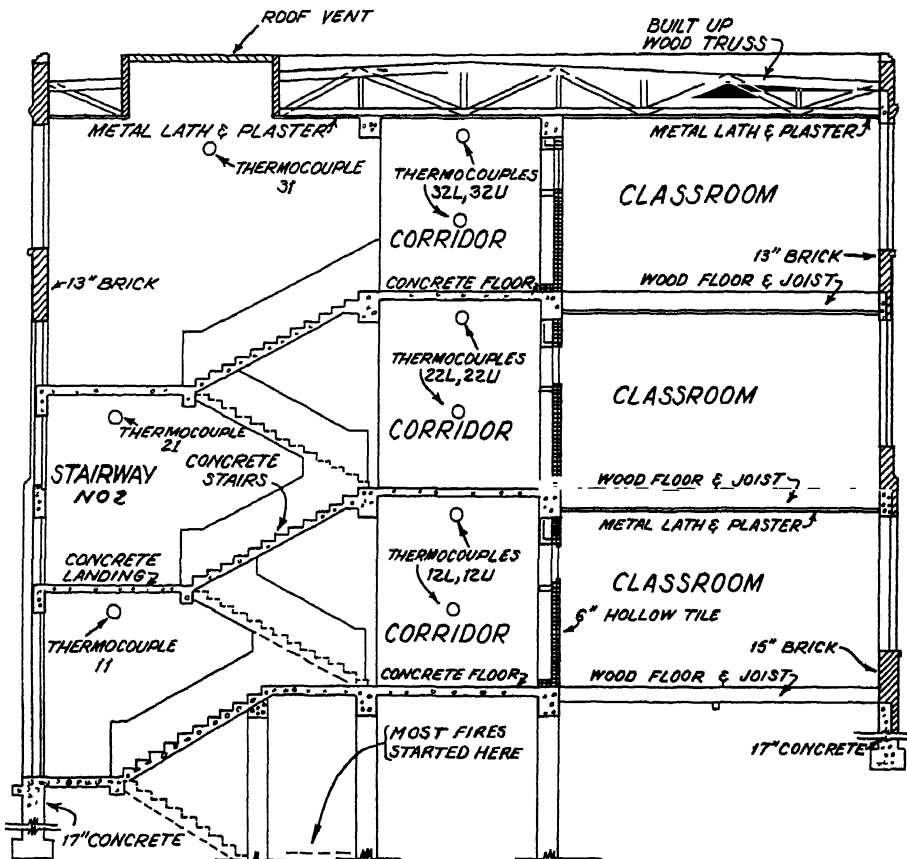


Figure 14. Cross-section through test building.

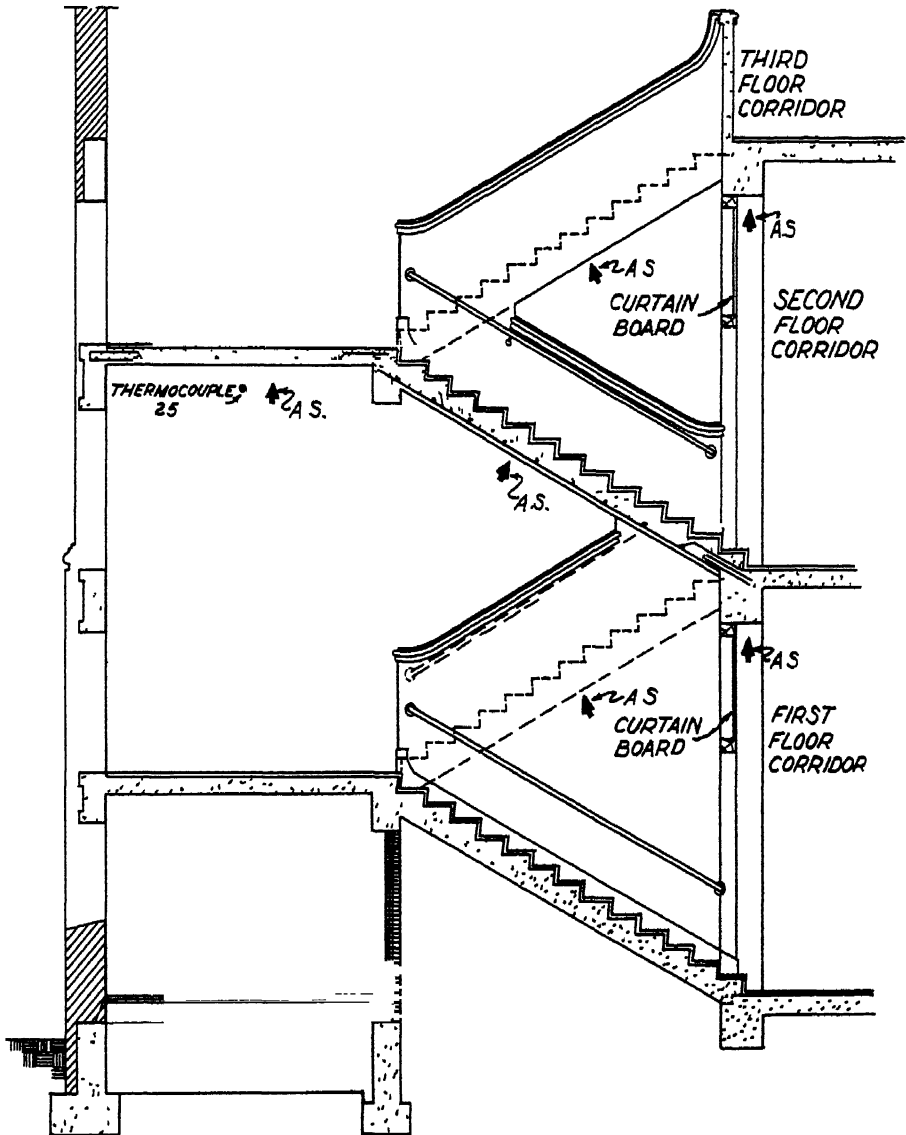


Figure 15. Section through stairway No. 1 (west).



## Part III

### Criteria of Untenability and Evacuation

Throughout this report reference is made to untenable smoke and temperature conditions. The basis on which these levels were determined are discussed below.

#### Untenability Due to Smoke

Untenable smoke conditions were based on two combined factors: (1) visibility and (2) the irritant effects of the products of combustion. Visibility was determined by placing an illuminated placard 5 feet from the floor and bearing a 12-inch letter, 45 feet down the hallway from an observer. When the letter was no longer visible to the observer, the time was recorded as the point of untenable smoke conditions.

The judgment of firemen observers and others (nonfire department personnel) determined when the products of combustion were so irritating that students and teachers could not withstand the conditions during the time necessary to evacuate the multi-storied building.

These two determinations by observers were then correlated with the smoke density readings taken from the equipment installed by the American District Telegraph Company.

#### Untenability Due to Temperature

A maximum tenable temperature of 150 degrees Fahrenheit was established for use in interpreting the results of these tests. It is recognized that a human can stand temperatures considerably above 150 degrees Fahrenheit for very short periods of time

in a relatively dry atmosphere, but it was felt that school children and teachers would not be likely to enter a corridor from a cool room when the temperature at the 5-foot level in the corridor was more than 150 degrees Fahrenheit.

#### Evacuation Time

It has been estimated that an average 3-story school building with adequate exits can be evacuated in 2 to 3 minutes under practiced fire drill procedures. This estimated evacuation time is used throughout this report when reference is made to this subject.

### Summary of Results

The results which follow summarize findings based on the test results within the limitations previously stated. The test results indicate that most of the methods of protection tested did not provide satisfactory safeguards against smoke and heat conditions. It follows, therefore, that more testing is necessary if satisfactory methods of protecting occupants from fire and smoke are to be found.

#### GENERAL

1. With the test fires used in these tests and no fuel added to the fire due to the construction of the building, smoke (specifically as it pertains to visibility and irritant effects) was the principal life safety hazard. Untenable smoke conditions preceded untenable temperature conditions in nearly every test.

This might be expected with smoldering fires; however, this was true even with free-burning fires. In the base series of fires (no protective features), untenable smoke conditions were reached in 2 to 7 minutes on at least one entire floor above the fire. This series included fires at the bottom of a stairway as well as fires in rooms. Conditions within the building were varied by having the doors, windows and transoms in both the open and closed positions.

#### SMOKE AND HEAT VENTING

**2. Natural draft vents of the sizes tested in this investigation and installed and opened as described in each test did not keep corridors and stairways tenable for exit use.**

In this series of fires untenable smoke conditions were reached in 4 to 5 minutes from the start of the fire, on at least one entire floor above the fire. When vents were opened by means of fusible links, untenable smoke conditions were reached several minutes before the vents opened. Even when vents were opened before the test fires were started, untenable smoke conditions followed in some cases. Opening of vents increased draft on the fire resulting in an increase in the rate of heat and smoke development that made smoke in the corridors and stairways more dense until vent action started. The action of vents eventually cleared smoke from the building but, by this time, untenable temperatures had been reached on all floors.

Smoke and heat vents are not effective unless fresh air is supplied to the building from the outside to replace the exhausted air. Opening of exterior exit doors at times when they would be opened by occupants leaving

the building under fire conditions aided the action of the vents somewhat but not sufficiently to consider the vents effective for life safety purposes.

The capacity of a natural draft vent is proportional to the difference in temperatures between the inside and outside air. The temperatures in the building as a result of the fires in these tests did not provide a temperature differential sufficient to produce pressure for an adequate stack effect through the vents before the stairways and corridors became untenable from smoke and heat. It has been estimated that the maximum burning rate of the test fire resulted in a heat release of approximately 550,000 Btu per minute. Assuming that 25 to 30 per cent of the heat released was absorbed by the building and its contents, this leaves roughly 400,000 Btu per minute to be exhausted out of the building. Removing this amount of heat at an exhaust temperature of 250 degrees Fahrenheit would require the removal of approximately 170,000 cubic feet per minute (with an ambient temperature of 70 degrees Fahrenheit).<sup>\*</sup> Velometer readings taken during some tests indicated that the 63 square foot vent exhausted a maximum of approximately 50,000 cubic feet of air per minute.

The unsatisfactory results concerning the effectiveness of natural draft vents should not be considered as evidence of the unsuitableness of vents for all uses. Vents in industrial, warehouse, and similar occupancies are a proven desirable feature to minimize fire damage and to facilitate fire fighting under certain conditions.

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<sup>\*</sup>Based on the formula: Heat removed = weight of air  $\times$  temperature rise (absolute)  $\times$  specific heat.

However, the tests reported herein on natural draft vents were conducted to investigate the life safety possibilities through their use in the multistory building used for test purposes.

**3. The addition of curtain boards (draft or fire curtains) with roof vents did not significantly aid in decreasing smoke spread through the building and, in fact, had an adverse effect on the action of the vents in some tests.**

Curtain boards, while not effective against smoke spread, did "bank" heat as would be expected (The latter has been the primary purpose of curtain boards in industrial fire protection applications) Smoke "cutoff" is more important than heat "banking" where life safety is the objective.

**4. Forced draft up to the capacity tested failed to produce any more satisfactory venting action.**

*Forced draft venting by motor-driven blower or water spray induced draft has an advantage in that it will remove smoke and irritant gases from fires with a heat output too low to raise temperatures high enough to permit proper functioning of natural draft vent systems. Blowers, however, are dependent on electric power, and such installations are expensive. Draft by induction from water spray nozzles requires about  $2\frac{1}{2}$  gallons of water per minute per square foot of vent opening, and discharge velocities of about 800 feet per minute are obtainable considering the air flow friction from air inlet to vent. To prevent a rise in building temperatures with a fire of net heat output of 400,000 Btu per minute would require a vent open-*

*ing of 200 square feet and a water spray discharge of about 500 gallons per minute at 25 pounds per square inch gage or more.*

#### AUTOMATIC SPRINKLER PROTECTION

**5. A complete system of automatic sprinklers will maintain low temperatures throughout the building and will reduce build-up of smoke and irritating gases.**

With a complete automatic sprinkler system, untenable smoke conditions were not reached in any corridors except two local areas closest to the test fire.

However, when the test fire was arranged so as to provide extensive shielding against sprinkler water distribution, untenable smoke conditions developed in the corridor of fire origin and those above. Under these conditions, the fire was held in check but not extinguished by the sprinklers. This points to the necessity of eliminating any arrangement in the building or its contents that could shield a fire from sprinkler discharge.

**6. Partial automatic sprinklers (sprinklers installed in corridors and stairways but not over the test fire) did not prevent smoke spread throughout the building even when installed to provide a water curtain between the test fire and the corridors.**

The purpose of placing sprinkler heads in exitways only in certain tests was to evaluate a type of installation that had been suggested as suitable to protect exitways so that occupants could escape safely.

Operating sprinklers in the building kept temperatures in the corridors at or below the tenable level (150 de-

grees Fahrenheit), but in many cases untenable smoke conditions existed in the building before sprinklers operated. Furthermore, in the cases when sprinklers opened, steam resulting from their operation drove observers from the immediate vicinity.

Water discharge from a sprinkler head is not designed to provide a smoke barrier but rather to distribute water over a specific area at a rate capable of absorbing heat in quantities sufficient to cool the burning material below its kindling temperature. Sprinklers are usually installed to cover all areas and obstructions should be removed to facilitate good water distribution. These two conditions for satisfactory sprinkler performance were intentionally disregarded.

#### COMBINATIONS OF VENTS AND PARTIAL AUTOMATIC SPRINKLERS

**7. Roof vents and partial automatic sprinklers (sprinklers installed in corridors and stairways but not over the test fire) were not an effective combination.**

Sprinkler action was similar to that in tests without vents. Natural draft vent action was slowed down considerably due to the low temperatures existing within the building resulting from the operation of sprinklers. Forced draft effectiveness with the water aspirator was similar to that in tests without sprinklers.

**8. Combinations of roof vents, curtain boards (draft or fire curtains), and partial automatic sprinklers (sprinklers installed in corridors and stairways but not over the test fire) did not prove to be satisfactory.**

Untenable smoke conditions existed in all corridors before sprinklers operated. Sprinkler cooling action tended to nullify the thermo-siphon effect of the roof vents in addition to producing steam. The curtain boards did not improve vent action.

#### FUSIBLE LINK ACTUATED DEVICES

**9. Untenable smoke conditions existed in the building before the operation of fusible link actuated devices.**

Untenable smoke conditions, and in many cases untenable heat conditions, existed within the building before the opening of vents actuated by fusible links. This was true even with the free-burning test fires. Under the conditions of these tests, untenable smoke conditions existed before temperatures were reached at which fusible link actuated devices would operate.

**10. Enclosed stairways will not provide protection against heat and smoke unless the doors are kept closed or are closed immediately after an outbreak of fire.**

Tests employing temporary enclosure of stairs, except for the door opening, showed that if stairway doors are not closed when fire occurs or immediately thereafter, heat and smoke will make corridors and stairs untenable in about the same time as though they were not enclosed at all. Present-day fusibly operated door closing devices will not operate rapidly enough to close doors before corridors are untenable. Automatic closing devices activated by the ordinary heat responsive fire alarm system would not be fast enough to guard against spread of smoke.

## AUTOMATIC FIRE DETECTION EQUIPMENT

**11. Automatic heat detection devices detected the presence of fire at about the same time that untenable smoke conditions were reached within the building.**

Prompt notification of fire was experienced when detection equipment was located *directly over the test fire*. Fire detection devices when spaced at the maximum distance recommended will operate in two minutes or less when subjected to the standard fire test conditions used by testing laboratories. Under the conditions of the tests discussed in this report, a fire signal in 2 minutes would *not* allow sufficient time for safe evacuation of the building.

**12. Automatic smoke detection devices detected the presence of fire before untenable smoke conditions were reached, but not in sufficient time to allow complete evacuation of the test building.**

It appears that automatic smoke detection devices, *if directly over the test fire*, would provide an early notification of fire and could allow reasonable time for evacuation of students. However, it is questionable if smoke detection devices would allow reasonable time for evacuation of occupants under all conditions.

## MODIFICATION OF STAIRWAYS

**13. Opening a hole to provide a vertical flue in the stairways did not significantly change any of the results.**

This hole (shown in Figure 3) was opened in the stairways in order to provide a vertical flue in an attempt to overcome the circuitous route for

smoke and heat. With the stairways open, smoke and heat circulated through the building somewhat faster but the effectiveness of roof vents, curtain boards and automatic sprinklers was not improved.

## CELLULOSE FIBER ACOUSTICAL TILE

**14. Cellulose fiber acoustical tile (classified Class C under U. S. Federal Specification SS-A-118b and commonly known as "slow-burning") resulted in very rapid fire spread when ignited. This constituted a distinct hazard in that it was the means by which fire could be readily transmitted throughout the building endangering all portions and persons therein. The rapid flame spread characteristic of the tile can be reduced with the application of a fire retardant paint (Underwriters' Laboratories, Inc., listed).**

The cellulose fiber tile ignited at temperatures from 700 degrees to 800 degrees Fahrenheit and the flame progressed with a "wave-like" action for a few minutes, then suddenly developed a deep (3-foot to 5-foot) flame front that spread with such rapidity (5 to 10 feet per second) that observers fled their posts. In one demonstration fire (not included in this report because it was not part of this series) the flame spread rapidly over the surface of the cellulose fiber acoustical tile even though the ceiling was broken into bays, 5 feet by 5 feet in size, separated by ceiling beams 2 feet in depth.

## Remarks

The speed at which untenable smoke conditions were reached in these tests emphasize the need for prompt notification of fire conditions

and rapid evacuation of occupants from school buildings. A review of the time available for evacuation may prompt school administrators to re-evaluate their fire drill procedures

The results of the tests conducted on cellulose fiber acoustical tile indicated the fallacy of using a performance test (e.g., U. S. Federal Specification SS-A-118b) as a fire test. Such tests are not designed as fire tests to simulate performance under actual fire conditions.

An automatic sprinkler installation involving *other* than complete coverage may afford a degree of protection when installed in areas most subject to fires and connected to the school fire alarm system. However, as shown in these tests, it will *not* prevent smoke spread, and when not installed over the fire, untenable conditions can exist when sprinklers are operating. These conditions involve smoke and moist heat. Therefore, any such installation should only be on recommendation of a competent fire protection engineer after a careful evaluation of all factors relating to the problem.

Automatic fire detection systems must be in operative condition at all times when relied upon to provide an alarm for evacuation of occupants. This requires continual supervision and regular maintenance and servicing. However, evacuation of a building equipped with an automatic fire detection system should be faster than in the same building protected by a complete automatic sprinkler system. The automatic sprinkler system may be expected to extinguish or control the fire which would allow more time for evacuating occupants.

## Future Investigations Recommended

A study of these tests pointed to the need for further research. The following are some suggested areas where further research could produce some additional helpful data.

1. More tests are needed of vents of larger sizes, possibly up to the total area of the stairway enclosure, with corridor curtain boards. The vents should be operated so that they will be open before untenable smoke conditions prevail in the test building. Any favorable results that may be obtained should be weighed against the economic and practical problems encountered in the use of large vents.

2. The relatively fast operation of the automatic smoke detection equipment in some of the tests discussed in this report indicates the need for further research on automatic detection equipment which is actuated by smoke in order to obtain reliable early notification of fire conditions for evacuation of students and other personnel.

3. There is a great need for a standard method of classifying the sensitivity of fire and smoke detection equipment as it relates to response time for the area protected. As previously pointed out, when detection equipment is spaced at the maximum distances recommended, it should give an alarm in two minutes or less when subjected to the standard test fire. There is no information available on response time when spaced at lesser distances.

4. These tests indicated that thermal devices on door closers were slow to operate. Further research should be done on other methods of opening or closing doors.

5. Tests should be conducted in buildings of other types of construction and with different arrangements and numbers of stairways to determine if there would be any variation from the results obtained in the tests reported herein.

6. The smoke conditions experienced in these tests indicated that smoke can be the critical factor in defining life safety in schools and therefore flame spread characteristics should not be the sole criterion for determining the life hazard of interior finish materials. A study should be made on tenable levels of smoke generation. Standards should be developed for classifying interior finish materials based on these predetermined tenable levels.

7. A minimum number of tests were run to simulate complete auto-

matic sprinkler coverage because sprinkler performance has been tabulated for many years and has been shown as excellent for the protection of property. More tests should be run simulating complete coverage to obtain more data on operating times in relation to smoke conditions with various sizes of test fires. These tests should include the installation of sprinklers designed for fast operation.

8. It would be desirable to test some interior finish materials that have been listed by Underwriters' Laboratories, Inc., as having been subjected to the "tunnel test" [NFPA Standard, Fire Hazard Classification of Building Materials (No. 255)] to verify the classification of such materials for life safety purposes based on the flame spread rating determined by this Standard.

## Part IV

### Individual Test Results

The following pages contain the detailed information obtained from each test and the conditions prevailing during each test. The tests have been grouped in Series (see page 6) corresponding to certain protection or conditions being studied

Tests other than those included in this report were conducted, but these were not specifically a part of the series reported herein and therefore are not included.

Included with the data on each test is a graphical presentation of its most significant features. Data not pertinent to a test have been omitted from the graphs.

The comments indicated with the data for each test are an analysis of pertinent features of the test results. All comments were correlated to make the final results which are contained in the preceding pages.

Users of the information which follows should bear in mind that the results are for the conditions indicated and from a test fire in the specific building utilized for these tests. Other prevailing conditions, kinds of fires, or types of buildings may produce different results.

### Smoke Density Data

The readings taken by the American District Telegraph Company from the photoelectric cells were in microamperes and were recorded at  $\frac{1}{2}$ -minute intervals. These results were graphed as indicated in the graphical presentation of individual tests which follow. The determination of the light, medium and dense smoke conditions was derived from a correlation of results from research

previously conducted by the American District Telegraph Company and the data sheets of the six fire department observers who recorded what they felt were light, medium and dense smoke conditions during each test

### Pressure

Each graduation on the manometer scales was the equivalent of 1/100 inch of water pressure. Manometer readings are given in inches of water in the data that follow.

### Simulated Conditions

In some tests, conditions that would exist in an occupied school in a fire situation were simulated. For example, the opening of the exit doors at the west end of the first floor corridor is a logical sequence of events that could occur after occupants of the building were notified of fire.

Similarly, the opening of classroom doors, at a time when occupants had been notified of fire conditions, was tried in some tests.

Operating conditions in winter were simulated by a completely closed building; summer conditions by the opening of a representative number of doors, windows and transoms.

### Opening of Vents

It will be noted that in some tests the vents were operated when the temperature at the thermocouple nearest the test fire was 150–200 degrees Fahrenheit. This was to simulate opening of the vent by a heat sensitive device.

Opening the vent at temperatures above 165 degrees Fahrenheit was done to compensate for the fact that the building was still warm from a previous test.

## **Series A**

### **Base Criteria**

This series was conducted to establish base criteria with which other tests could be compared. Winter and summer conditions were simulated by leaving the building closed or open.

### **Test A-1**

**Date:** May 11, 1959

**Outdoor Temperature:** 70° F   **Humidity:** 66%   **Wind:** 4.9  
m.p.h. W Average

**Fuel:** 1,400 pounds of pallets

**Location of Test Fire:** Base of stairway No. 2

**Automatic Sprinklers:** None

**Vents:** None

**Curtain Boards:** None

**Automatic Fire Detection:** None

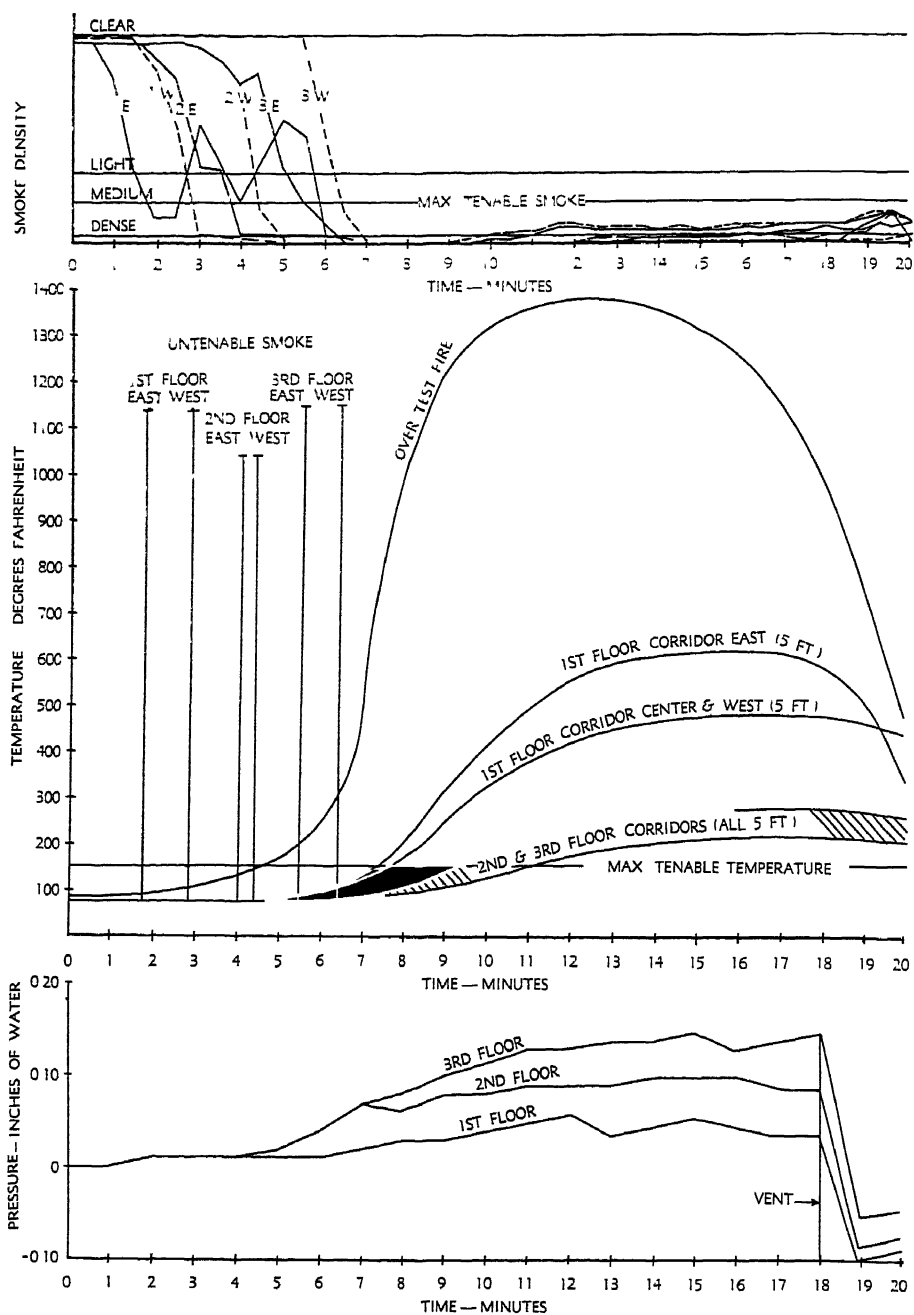
**Other:** Building completely closed

**Comments:**

All floors became untenable due to smoke conditions 4 to 5 minutes before the maximum tenable temperatures were reached.

Test fire was relatively slow in developing.

Maximum pressure of 0.15 inches of water reached at third floor in 15 minutes.



### Temperature and Pressure Readings

FIRST FLOOR								
Time Min- utes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11	12U	12L	13U	13L	14U	14L	
1	85	80	80	85	85	85	75	0.00
2	90	85	75	85	85	85	75	0.01
3	105	90	80	85	85	85	75	0.01
4	120	100	80	90	85	85	75	0.01
5	165	110	85	100	85	90	85	0.01
6	240	165	95	120	90	105	95	0.01
7	555	280	135	200	105	165	125	0.02
8	990	515	210	340	175	285	155	0.03
9	1230	675	325	425	255	365	215	0.03
10	1320	750	405	480	320	415	285	0.04
11	1335	820	475	520	365	445	365	0.05
12	1355	920	555	530	385	465	405	0.06
13	1375	920	580	565	425	485	435	0.04
14	1335	900	590	575	450	490	455	0.05
15	1280	900	565	575	460	490	445	0.06
16	1275	875	595	580	465	505	470	0.05
17	1235	880	600	580	465	505	460	0.04
18	875	865	580	565	465	505	460	0.04
19	755	615	580	530	475	480	435	-0.10
20	475	400	315	445	440	410	360	-0.09

SECOND FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	21	22U	22L	23U	23L	24U	24L	25	
1	75	75	75	85	80	85	85	85	0.00
2	75	75	75	85	85	85	85	85	0.01
3	80	80	75	85	85	85	85	85	0.01
4	85	80	75	85	85	85	85	85	0.01
5	90	85	75	85	85	85	85	85	0.02
6	115	95	75	90	85	85	85	95	0.04
7	165	125	75	115	85	110	90	135	0.07
8	285	200	85	165	105	195	115	225	0.06
9	360	260	105	210	140	245	140	290	0.08
10	400	275	125	240	175	280	165	330	0.08
11	445	310	150	265	200	300	200	350	0.09
12	490	350	175	275	215	315	210	365	0.09
13	500	345	185	290	235	320	230	385	0.09
14	505	350	200	290	250	335	240	395	0.10
15	500	345	210	295	255	340	250	400	0.10
16	505	355	215	290	265	350	255	405	0.10
17	510	360	225	300	265	350	255	410	0.09
18	510	365	225	300	270	365	260	425	0.09
19	470	360	240	300	280	365	275	415	-0.08
20	405	325	250	290	280	335	300	345	-0.07

## Temperature and Pressure Readings

THIRD FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	31	32U	32L	33U	33L	34U	34L	35	
1	80	75	85	85	85	85	85	85	0.00
2	80	75	85	85	85	85	85	85	0.01
3	80	80	85	85	85	85	85	85	0.01
4	80	80	85	85	85	85	85	85	0.00
5	80	80	85	85	85	85	85	85	0.01
6	80	80	85	85	85	85	85	85	0.03
7	80	85	85	85	85	90	85	90	0.06
8	100	110	95	105	95	115	95	115	0.08
9	130	150	115	125	110	145	115	145	0.10
10	160	175	140	155	135	175	140	175	0.11
11	175	200	155	170	160	195	160	200	0.13
12	200	225	165	180	170	205	165	210	0.13
13	210	240	185	200	185	220	185	225	0.14
14	230	250	195	210	200	230	195	235	0.14
15	225	250	200	225	210	235	205	240	0.15
16	225	250	205	215	215	240	210	245	0.13
17	230	255	205	225	215	245	210	250	0.14
18	235	260	210	220	205	255	220	260	-0.05
19	195	240	205	225	215	260	215	275	-0.04
20	170	220	180	210	165	230	175	245	-0.04

**Test A-2**

**Date:** May 11, 1959

**Outdoor Temperature:** 70° F. **Humidity:** 66% **Wind:** 4.9  
m.p h W Average

**Fuel:** 1,400 pounds of pallets

**Location of Test Fire:** Base of stairway No 2

**Automatic Sprinklers:** None

**Vents:** None

**Curtain Boards:** None

**Automatic Fire Detection:** None

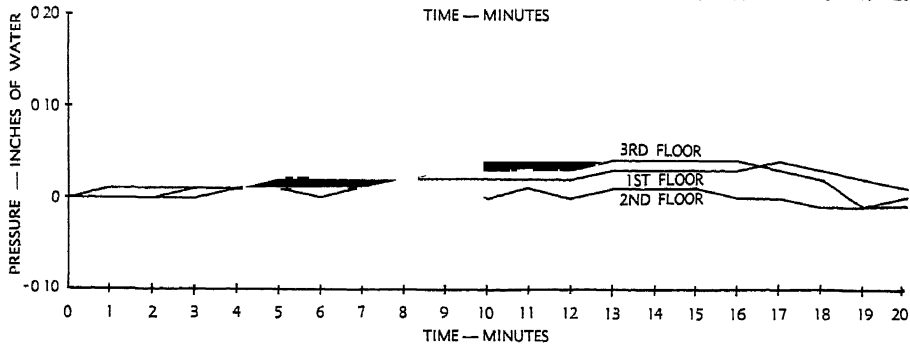
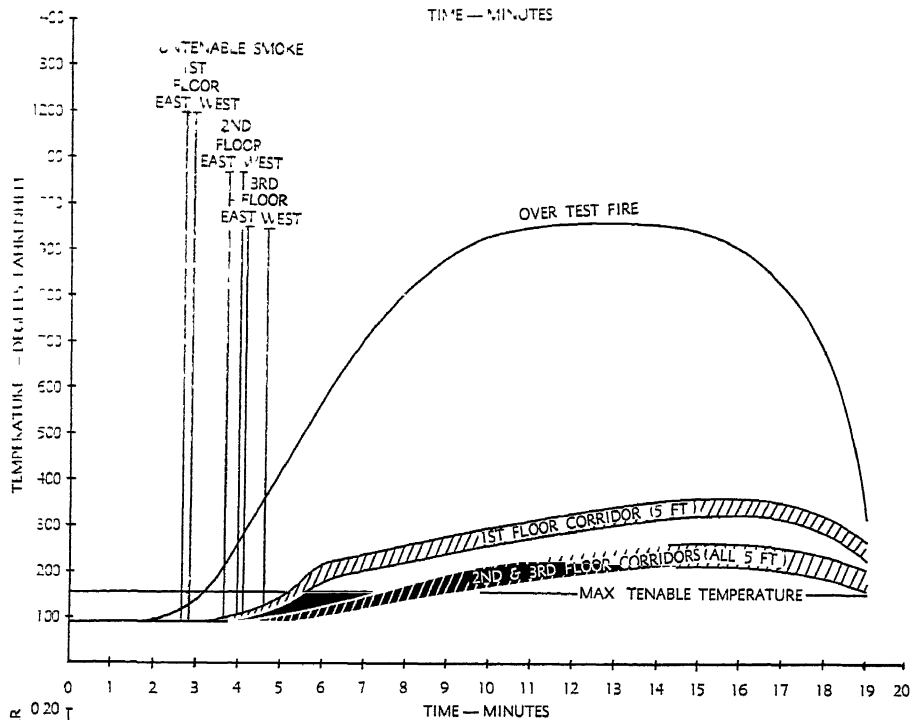
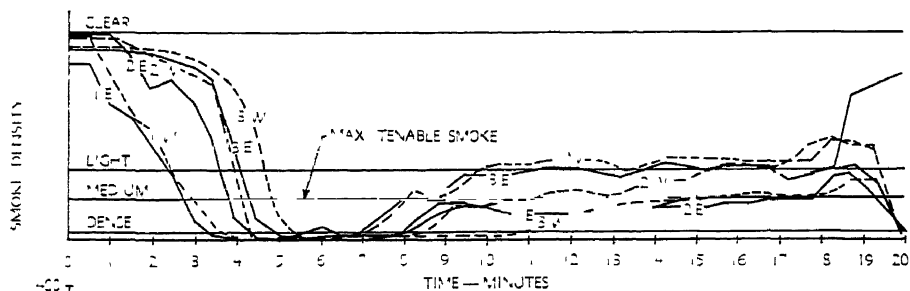
**Other:** One door in each room open to corridor. All exterior windows on south side open at top. Exterior windows on north side open from top and bottom. Exit doors on west end of first and second floor corridors and windows at west end of third floor corridor open

**Comments:**

Test fire developed faster than in Test A-1 but maximum temperature reached was lower.

Smoke circulation faster than in Test A-1 but untenable smoke conditions reached about the same time except on third floor which became untenable earlier than in Test A-1

Untenable temperature conditions at 5-foot level reached 2 minutes earlier than in Test A-1 but maximum temperatures reached were lower, particularly in the first floor corridor.



## Temperature and Pressure Readings

FIRST FLOOR								
Time Min- utes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11	12U	12L	13U	13L	14U	14L	
1	90	90	85	90	90	90	35	-0.01
2	90	90	85	90	90	90	35	-0.01
3	140	105	90	90	90	90	35	-0.01
4	285	150	100	135	120	105	95	-0.01
5	455	250	135	200	180	135	125	-0.02
6	600	350	215	260	230	180	185	-0.02
7	675	425	225	285	255	200	210	-0.02
8	785	475	220	325	285	225	210	-0.02
9	890	510	235	360	315	245	220	-0.02
10	925	570	300	390	350	275	255	-0.02
11	910	580	315	410	365	295	275	-0.02
12	910	595	305	415	375	305	285	-0.02
13	935	600	330	425	385	325	295	-0.03
14	935	695	355	435	395	345	315	-0.03
15	970	670	360	440	395	350	330	-0.03
16	950	635	330	430	390	350	310	-0.03
17	770	600	345	415	380	350	325	-0.04
18	725	565	290	400	365	320	285	-0.03
19	315	440	250	325	315	260	225	-0.02
20								

[illegible]



**Test A-3**

**Date:** May 12, 1959

**Outdoor Temperature:** 78° F   **Humidity:** 60%   **Wind:** 5 2  
m p h   W Average

**Fuel:** 1,400 pounds of pallets

**Location of Test Fire:** Classroom 204

**Automatic Sprinklers:** None

**Vents:** None

**Curtain Boards:** None

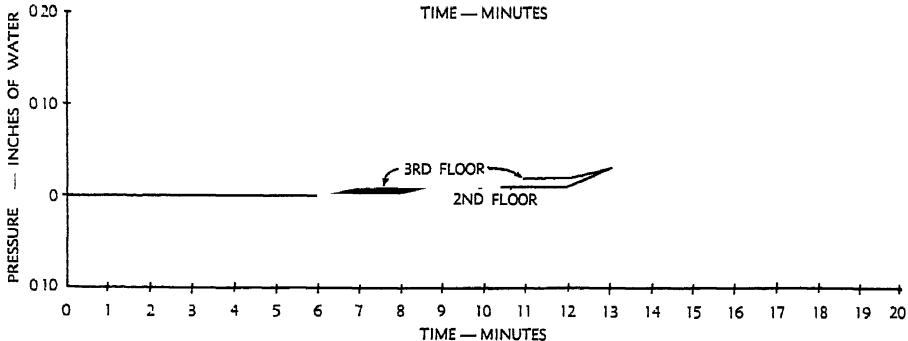
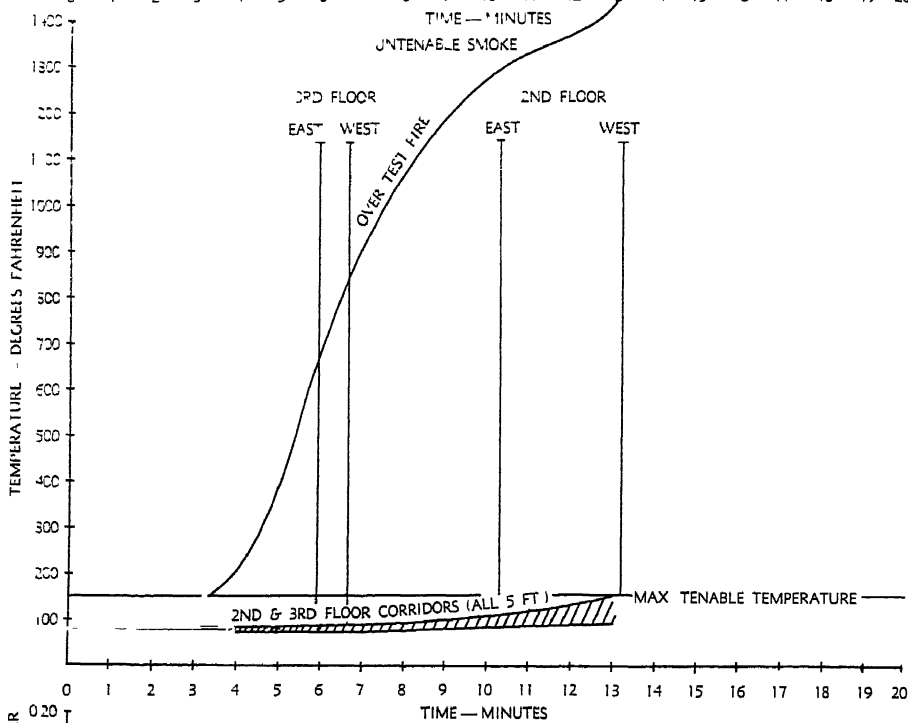
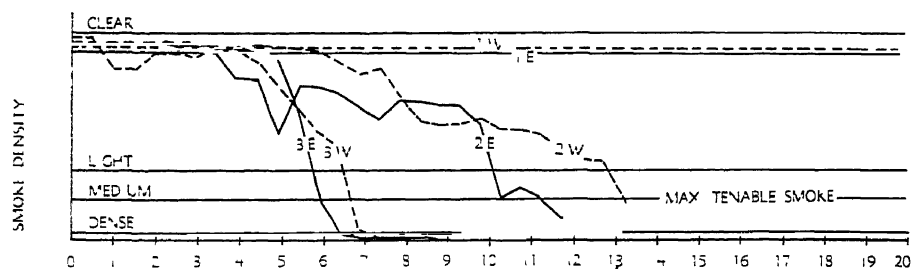
**Automatic Fire Detection:** None

**Other:** Windows in test fire room open and transoms between that room and the corridor open. Remainder of the building completely closed. No pressure readings taken in first floor corridor and no temperature readings taken at thermocouple No 13L

**Comments:**

Only the third floor corridor became untenable due to smoke early in the test. The east end of the second floor corridor became untenable from smoke only after 10½ minutes.

Maximum tenable temperatures were reached in the west end of the second floor corridor and the entire third floor corridor in 13 minutes







**Test A-4**

**Date:** May 12, 1959

**Outdoor Temperature:** 74°F   **Humidity:** 60%   **Wind:** 5.2  
m p h W Average

**Fuel:** 1,400 pounds of pallets

**Location of Test Fire:** Classroom 203

**Automatic Sprinklers:** None

**Vents:** None

**Curtain Boards:** None

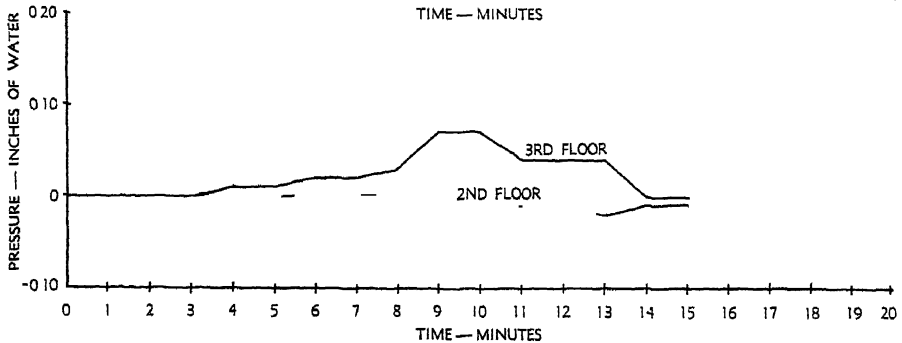
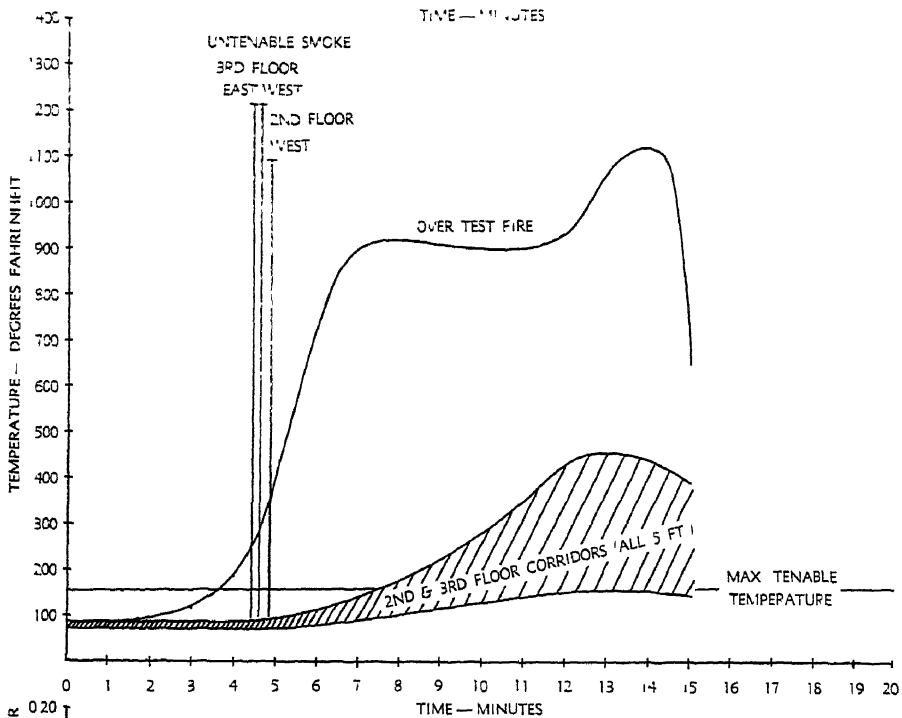
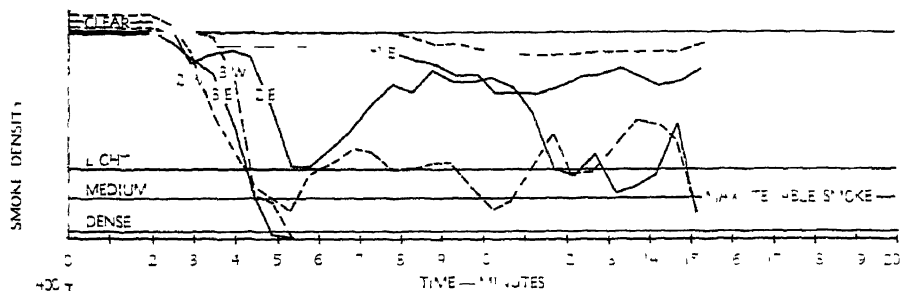
**Automatic Fire Detection:** None

**Other:** Two windows open one foot from bottom in classroom 203 and two transoms between that room and corridor open. Remainder of building open to simulate summer conditions as in Test A-2. No pressure readings taken in first floor corridor, and no temperature readings taken at thermocouples Nos. 12U and 21.

**Comments:**

The entire third floor corridor became untenable from smoke in 4 to 5 minutes and also the west end of the second floor corridor.

Maximum tenable temperatures were reached at all stations in the second and third floor corridors and sooner than in Test A-3



### Temperature and Pressure Readings

FIRST FLOOR								
Time Min- utes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11 *	12U	12L	13U	13L	14U	14L	
1	85		75	85	85	85	75	
2	95		75	85	85	85	75	
3	115		75	85	85	85	75	
4	185		75	85	85	85	75	
5	425		75	85	85	85	75	
6	755		75	85	85	85	75	
7	925		75	85	85	85	75	
8	900		75	85	85	85	75	
9	915		75	85	85	85	75	
10	895		75	85	85	85	75	
11	900		75	85	85	85	75	
12	915		75	85	85	85	75	
13	1050		75	85	85	85	75	
14	1130		75	85	85	85	75	
15	650		75	85	85	85	75	
16								
17								
18								
19								
20								

\*Classroom 203

[illegible]

## Temperature and Pressure Readings

[illegible]

## **Series B**

### **Natural Draft Vents**

This series of tests was conducted to determine the operation of fusible links on vents and the effectiveness of vents when no protection is provided in the building to reduce heat conditions.

#### **Test B-1**

**Date:** April 16, 1959

**Outdoor Temperature:** 69° F. **Humidity:** 59% **Wind:** 6.3  
m p h. W Average

**Fuel:** 1,400 pounds of pallets

**Location of Test Fire:** Base of stairway No. 2

**Automatic Sprinklers:** None

**Vents:** 21 square feet at top of stairway No. 2

**Curtain Boards:** None

**Automatic Fire Detection:** Coverage as shown in Figure 12

**Other:** Vent opened on operation of fusible link rated at 165 degrees Fahrenheit. Automatic smoke detection equipment installed in stairway No. 2 at first floor level. No smoke density or pressure readings taken during this test. Smoke data from observers only.

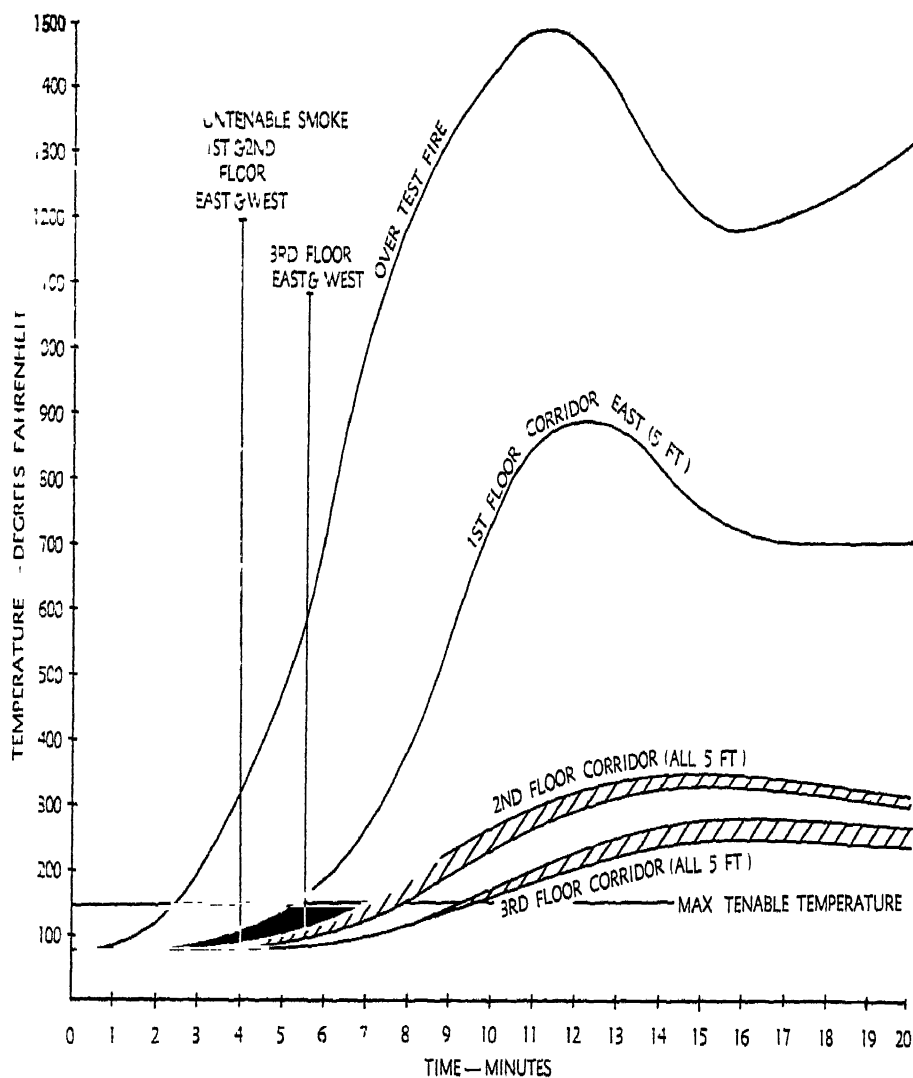
#### **Comments:**

Fusible link did not operate until 9 minutes from start of test fire

Relatively fast developing test fire

Smoke detection equipment in stairway No. 2 gave an alarm in 2 seconds

All floors untenable from smoke in from 4 to 5½ minutes Vent opened in 9 minutes



## Automatic Fire Detection System

Circuit No.	Area Covered	Response Time from Fire Start	
		Minutes	Seconds
1	1st Floor Corridor	2	25
2	2nd Floor Corridor	4	15
3	3rd Floor Corridor	5	56
4	Room 203	5	38
5	Stairway No. 2	1	30
6	Stairway No. 1	3	45

## Temperature and Pressure Readings

FIRST FLOOR								
Time Min- utes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11	12U	12L	13U	13L	14U	14L	
1	75	75	75	75	75	75	75	
2	110	80	75	75	75	75	75	
3	185	115	80	75	75	75	75	
4	360	205	125	100	75	75	75	
5	475	265	130	160	110	130	75	
6	725	385	180	200	110	160	100	
7	940	485	240	280	140	220	120	
8	1210	575	300	310	190	280	150	
9	1310	870	525	380	210	310	180	
10	1310	980	850	485	270	390	210	
11	1487	1095	855	665	400	530	400	
12	1475	1097	880	715	480	590	460	
13	1390	1025	897	720	525	615	475	
14	1270	950	815	735	550	635	495	
15	1182	860	745	720	550	630	490	
16	1200	818	710	665	535	600	450	
17	1198	780	710	630	505	565	440	
18	1265	780	695	605	490	545	435	
19	1312	780	730	600	480	535	435	
20	1315	735	705	605	480	540	440	

## Temperature and Pressure Readings

SECOND FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	21	22U	22L	23U	23L	24U	24L	25	
1	75	75	75	75	75	75	75	75	
2	75	75	75	75	75	75	75	75	
3	95	80	75	75	75	75	75	75	
4	145	100	75	75	75	75	75	75	
5	180	130	90	110	75	75	75	75	
6	255	180	120	130	100	115	105	75	
7	325	220	145	170	115	130	120	75	
8	350	245	170	185	150	160	145	75	
9	455	305	215	210	180	185	180	75	
10	575	385	270	255	215	220	210	75	
11	605	420	295	330	280	280	270	75	
12	620	445	325	365	310	315	315	75	
13	615	440	330	380	335	335	325	75	
14	580	430	330	390	340	340	345	75	
15	542	325	325	385	345	345	350	130	
16	525	320	320	375	330	335	340	95	
17	510	320	320	360	325	325	330	90	
18	495	310	310	355	325	320	320	90	
19	495	310	310	345	325	320	315	90	
20	495	310	310	340	325	320	315	90	

THIRD FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	31	32U	32L	33U	33L	34U	34L	35	
1	75	75	75	75	75	75	75	75	
2	75	75	75	75	75	75	75	75	
3	75	75	75	75	75	75	75	75	
4	80	80	75	75	75	75	75	75	
5	100	90	75	75	75	75	75	75	
6	125	110	90	85	85	100	80	100	
7	165	150	100	90	90	110	100	110	
8	185	170	115	110	110	130	115	130	
9	205	195	140	130	130	160	135	160	
10	225	225	160	155	155	170	145	200	
11	260	255	200	165	165	240	195	235	
12	280	275	225	200	200	275	240	280	
13	295	275	245	225	225	295	255	300	
14	290	270	260	240	240	305	270	320	
15	290	260	260	245	245	310	275	320	
16	270	265	260	245	245	305	280	310	
17	270	250	255	245	245	300	270	305	
18	270	250	250	245	245	295	270	300	
19	275	245	250	240	240	295	275	300	
20	275	250	250	240	240	295	270	300	

## Test B-2

**Date:** April 17, 1959

**Outdoor Temperature:** 65° F   **Humidity:** 65%   **Wind:** 6.0 m p h W Average

**Fuel:** 1,400 pounds of pallets

**Location of Test Fire:** Base of stairway No. 2

**Automatic Sprinklers:** None

**Vents:** 42 square feet at top of stairway No. 2

**Curtain Boards:** None

**Automatic Fire Detection:** Coverage as shown in Figure 12

**Other:** Vent opened on operation of fusible link rated at 165 degrees Fahrenheit. Automatic smoke detection equipment installed in stairway No. 2 at first floor level. No smoke density readings taken during this test. Smoke data from observers only.

### Comments:

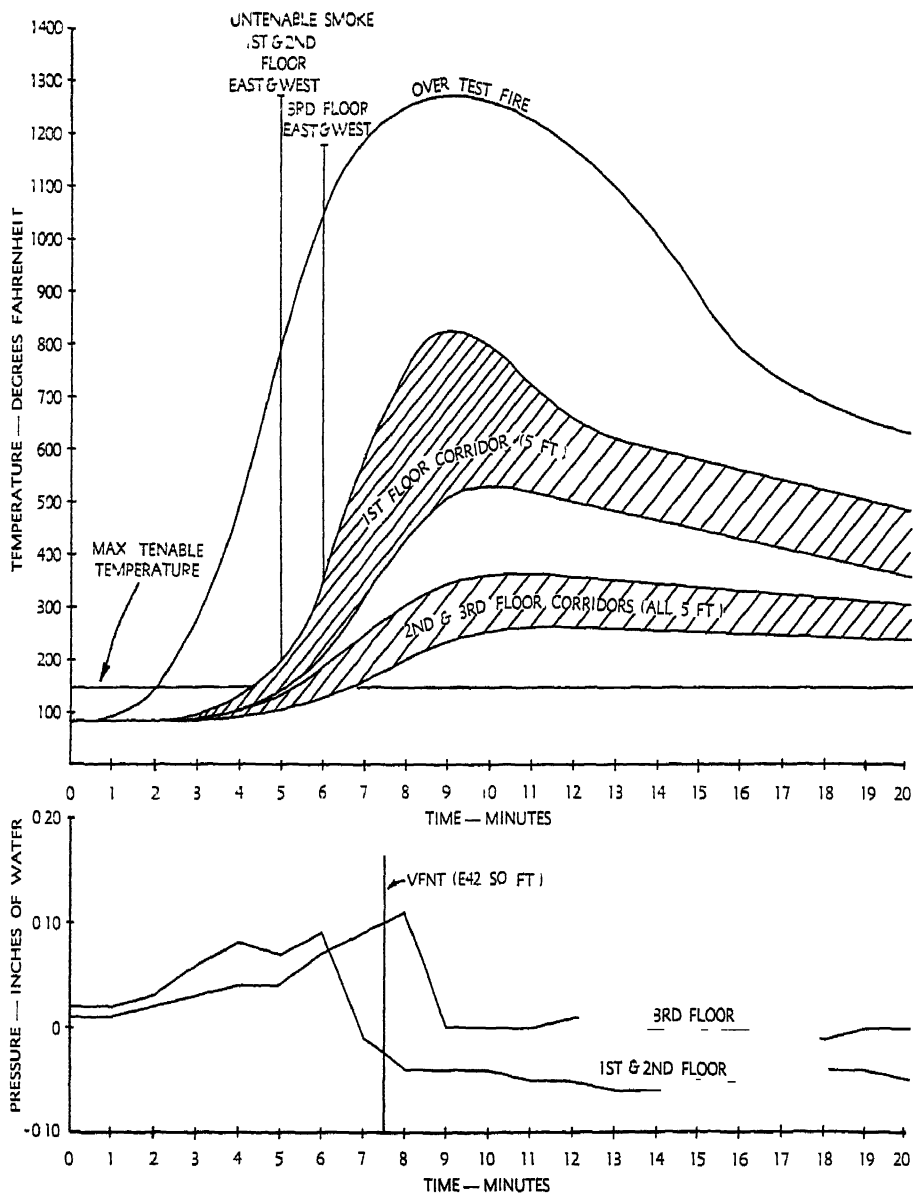
Fusible link operated in 7½ minutes, 2½ minutes after first floor corridor became untenable from smoke; 1½ minutes after third floor.

Maximum tenable temperature in the first floor corridor reached in 3-4 minutes.

Relatively fast developing test fire.

Automatic smoke detection equipment gave alarm in 21 seconds

Operation of automatic fire detection equipment was practically coincident with untenable smoke conditions in all corridors but no detection equipment was installed over the test fire



## Automatic Fire Detection System

Circuit No.	Area Covered	Response Time from Fire Start	
		Minutes	Seconds
1	1st Floor Corridor	4	15
2	2nd Floor Corridor	5	26
3	3rd Floor Corridor	6	19
4	Room 203	6	44
5	Stairway No. 2	Not used this test.	
6	Stairway No. 1	5	1

## Temperature and Pressure Readings

FIRST FLOOR								
Time Minutes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11	12U	12L	13U	13L	14U	14L	
1	90	90	73	85	80	80	72	0.02
2	130	90	80	90	80	85	72	0.03
3	340	175	80	145	90	115	77	0.06
4	485	337	130	190	100	145	122	0.08
5	765	515	193	300	145	230	165	0.07
6	1055	665	307	405	200	330	230	0.09
7	1255	877	585	535	305	440	300	-0.01
8	1265	932	770	665	470	565	440	-0.04
9	1270	900	840	710	540	620	520	-0.04
10	1220	865	790	700	555	620	525	-0.04
11	1140	850	710	685	545	590	515	-0.05
12	1110	822	630	650	535	570	485	-0.05
13	1180	795	635	615	515	555	465	-0.06
14	965	750	600	585	495	535	455	-0.06
15	870	720	607	565	475	520	445	-0.05
16	775	672	547	535	460	495	425	-0.05
17	715	625	527	505	440	470	400	-0.05
18	680	607	515	490	420	460	390	-0.04
19	645	580	497	475	405	440	380	-0.04
20	630	550	480	465	400	435	365	-0.05

## Temperature and Pressure Readings

SECOND FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	21	22U	22L	23U	23L	24U	24L	25	
1	80	78	75	80	80	80	80	80	0.02
2	80	76	75	90	80	80	80	80	0.03
3	115	95	80	145	85	95	85	90	0.06
4	202	145	90	190	95	110	100	165	0.08
5	297	200	125	300	135	145	130	240	0.07
6	387	265	175	405	180	185	170	300	0.09
7	465	315	210	535	230	235	230	420	-0.01
8	575	415	280	665	305	305	305	480	-0.04
9	595	430	345	710	350	350	335	525	-0.04
10	590	435	345	700	360	355	350	530	-0.04
11	600	440	350	655	355	350	355	505	-0.05
12	575	435	350	650	350	355	360	485	-0.05
13	545	412	330	615	345	345	345	480	-0.06
14	525	405	325	585	335	335	340	460	-0.06
15	507	395	330	565	335	335	335	450	-0.05
16	475	380	310	535	325	325	330	425	-0.05
17	450	365	310	505	310	315	320	410	-0.05
18	432	352	300	490	305	305	315	405	-0.04
19	425	350	295	475	300	300	305	395	-0.04
20	407	340	290	465	295	300	305	380	-0.05

THIRD FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	31	32U	32L	33U	33L	34U	34L	35	
1	75	75	80	80	80	80	80	80	0.01
2	75	75	80	80	80	80	80	80	0.02
3	80	80	80	80	80	80	80	80	0.03
4	103	95	85	90	85	90	85	90	0.04
5	145	130	105	120	100	120	100	120	0.04
6	195	170	135	150	130	160	130	155	0.07
7	185	175	155	200	155	235	190	240	0.09
8	235	215	190	235	185	275	230	275	0.11
9	265	255	230	280	225	315	275	320	0.00
10	280	265	250	295	250	330	290	340	0.00
11	285	270	260	300	265	330	300	350	0.00
12	282	275	260	295	265	320	295	340	0.01
13	275	220	255	290	255	315	290	335	0.00
14	270	265	255	290	260	310	290	330	0.00
15	275	265	255	285	255	305	285	320	0.00
16	270	260	250	285	255	305	280	320	0.00
17	255	255	250	275	250	290	270	305	0.00
18	255	250	245	270	250	290	270	305	-0.01
19	250	245	240	265	245	280	265	295	0.00
20	245	240	235	260	240	275	255	290	0.00

**Test B-3**

**Date:** May 19, 1959

**Outdoor Temperature:** 83° F. **Humidity:** 51% **Wind:** 47  
m p.h W Average

**Fuel:** 1,400 pounds of pallets

**Location of Test Fire:** Base of stairway No. 2

**Automatic Sprinklers:** None

**Vents:** 42 square feet at top of stairway No. 2

**Curtain Boards:** None

**Automatic Fire Detection:** None

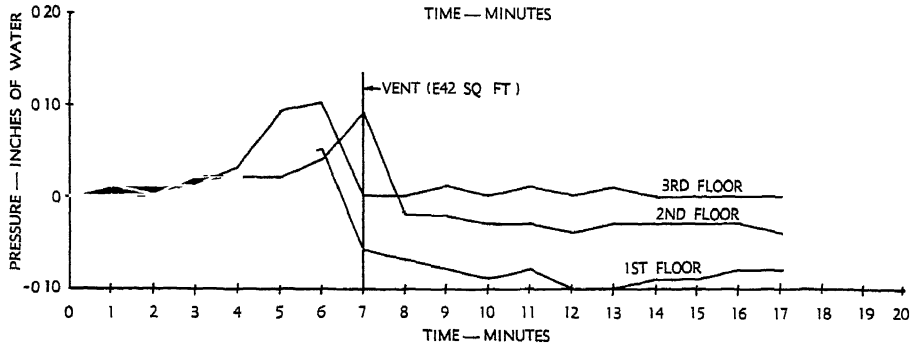
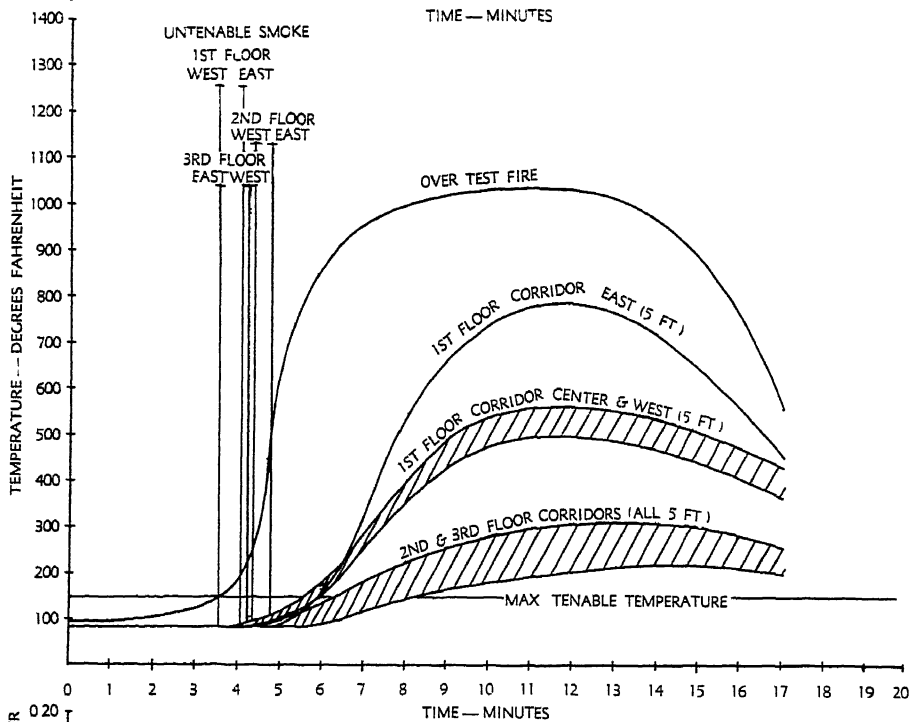
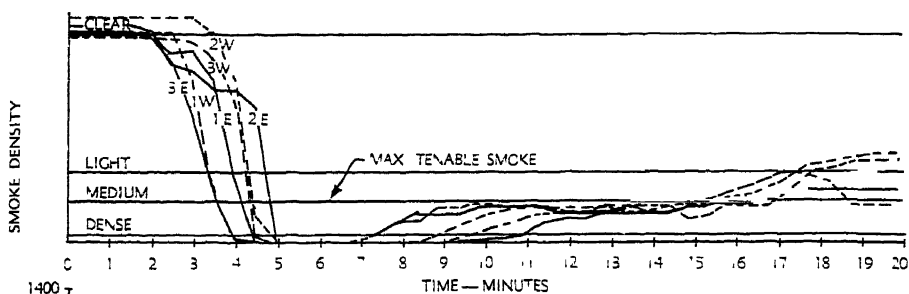
**Other:** Vent opened on operation of fusible link rated at 165 degrees Fahrenheit Center of stairway No. 2 opened to provide unobstructed passage to the top

**Comments:**

Fusible link operated in 7 minutes. Untenable smoke conditions in first floor corridor in 3 to 4 minutes; second floor, 4 to 5 minutes, third floor, 3 to 4 minutes

Maximum tenable temperatures reached in first floor corridor in 5-6 minutes; second floor, 6-8 minutes; third floor, 6-8 minutes.

Opening in stairway decreased time to reach untenable smoke conditions in upper floor corridors



## Temperature and Pressure Readings

FIRST FLOOR								
Time Min- ute	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11	12U	12L	13U	13L	14U	14L	
1	95	85	85	85	85	85	85	0.00
2	105	85	85	85	85	85	85	0.00
3	125	95	85	85	85	85	85	0.01
4	165	105	85	95	90	90	85	0.02
5	685	190	90	165	110	135	90	0.04
6	835	435	175	300	215	255	170	0.05
7	1020	620	275	360	260	305	240	-0.06
8	960	740	550	475	400	415	365	-0.07
9	975	800	660	550	500	485	435	-0.08
10	1025	805	740	590	545	520	445	-0.09
11	1045	830	790	615	550	540	480	-0.08
12	1025	800	760	625	550	550	510	-0.10
13	1040	780	775	600	550	530	490	-0.10
14	940	780	725	575	540	515	475	-0.09
15	940	675	615	540	515	485	440	-0.09
16	755	545	550	485	460	435	410	-0.08
17	560	475	460	425	450	385	370	-0.08
18								
19								
20								

[illegible]



## Series C

### Sprinklers Not Over Fire

The four tests in this series involve only automatic sprinklers but no sprinkler over the test fire. They were conducted for two reasons: to establish base criteria for comparison with other tests with sprinklers and other forms of protection and to determine if sprinklers in corridors and stairways will keep smoke and heat to tenable levels when fire originates in an area not protected by sprinklers.

#### Test C-1

**Date:** April 18, 1959

**Outdoor Temperature:** 61° F. **Humidity:** 57% **Wind:** 6.3 m p h **W Average**

**Fuel:** 1,400 pounds of solid pallets

**Location of Test Fire:** Base of stairway No. 2

**Automatic Sprinklers:** In corridors only

**Vents:** None

**Curtain Boards:** None

**Automatic Fire Detection:** Coverage as shown in Figure 12

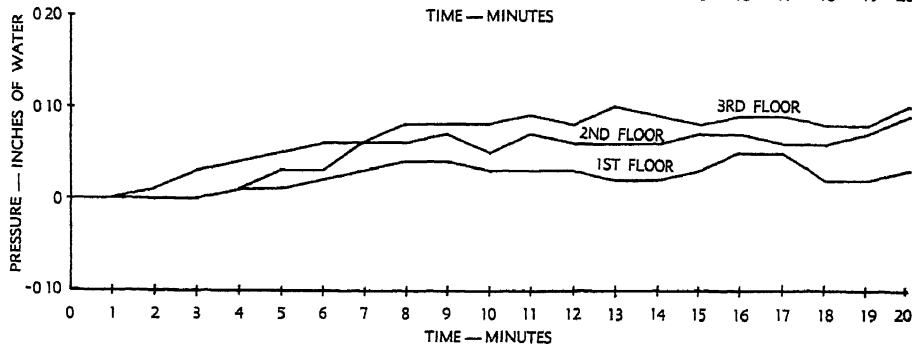
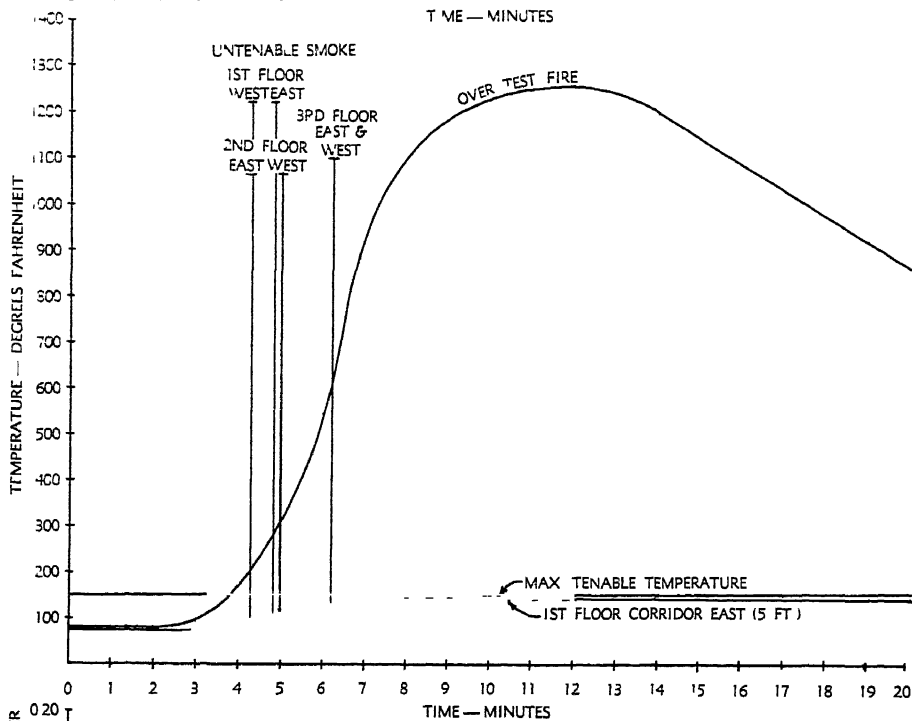
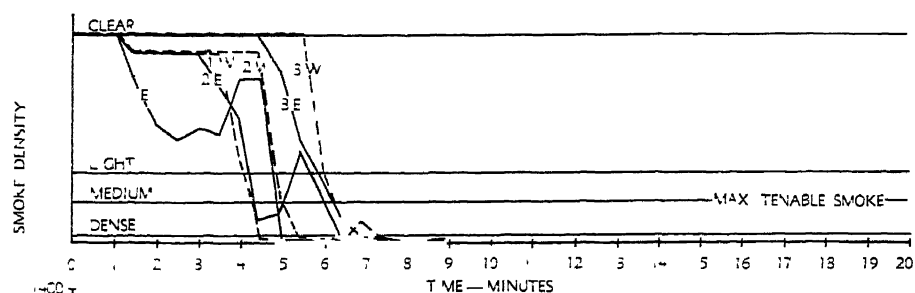
**Other:** Automatic smoke detection equipment installed in stairway No. 2 at the first floor level.

#### Comments:

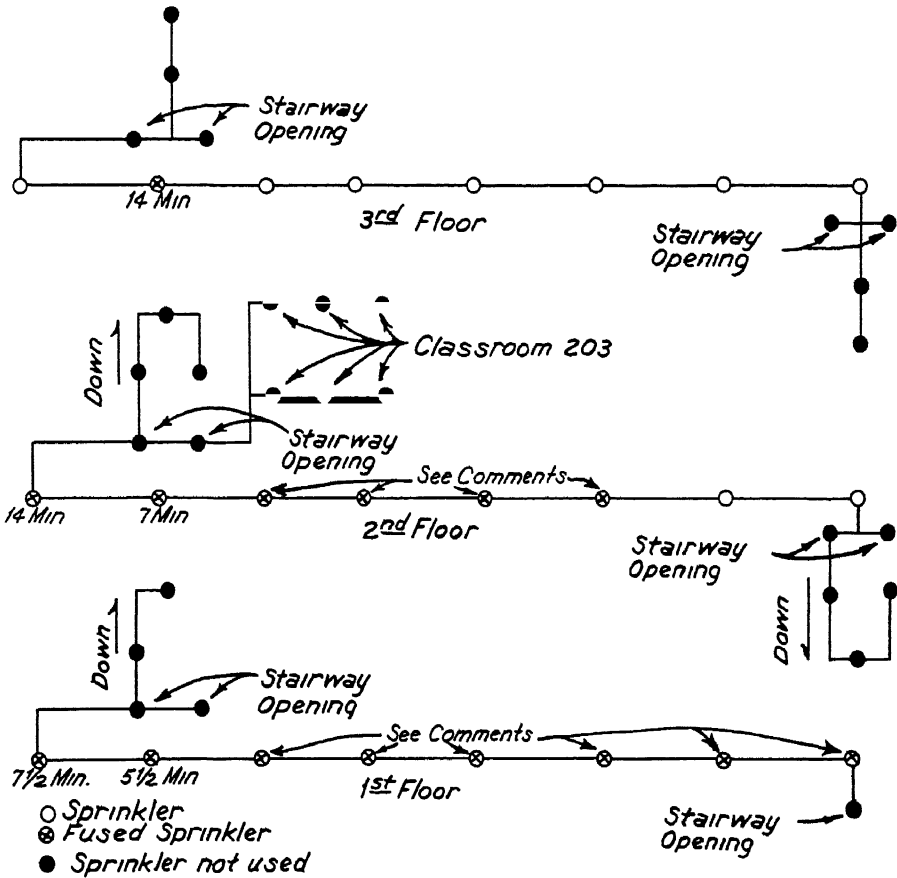
Automatic fire detection alarm received from circuit in stairway No. 2 before smoke conditions became untenable in any corridors.

Smoke detection equipment gave alarm in 1 minute 6 seconds.

No sprinklers operated before the first and second floor corridors became untenable from smoke. Sprinklers failed to prevent smoke spread but did keep temperatures down to slightly above and below the maximum tenable level.



## Automatic Sprinkler Operation



## Comments on Sprinkler Operation:

Sprinklers Utilized - corridors only.

In this test the water supply to the automatic sprinklers was turned off before the test fire was extinguished. Because of this, some of the sprinklers with unknown actuation times fused after the water supply was turned off.

## Automatic Fire Detection System

Circuit No.	Area Covered	Response Time from Fire Start	
		Minutes	Seconds
1	1st Floor Corridor	Not used this test	
2	2nd Floor Corridor	5	35
3	3rd Floor Corridor	7	10
4	Room 203	6	53
5	Stairway No. 2	3	25
6	Stairway No. 1	5	10

## Temperature and Pressure Readings

FIRST FLOOR								
Time Min- utes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11	12U	12L	13U	13L	14U	14L	
1	80	80	75	80	80	80	75	0.00
2	80	80	75	80	80	80	75	0.00
3	90	95	75	80	80	80	75	0.00
4	180	195	90	110	80	90	75	0.01
5	310	165	115	110	90	120	95	0.01
6	545	220	120	110	90	130	100	0.02
7	965	145	145	145	115	140	105	0.03
8	1090	140	140	160	115	140	110	0.04
9	1160	140	145	150	115	135	110	0.04
10	1230	145	145	145	120	130	115	0.03
11	1250	150	145	140	125	135	120	0.03
12	1260	145	145	140	130	135	125	0.03
13	1255	150	150	145	130	140	125	0.02
14	1200	150	150	140	130	130	125	0.02
15	1135	145	150	140	130	130	125	0.03
16	1080	145	145	140	130	125	125	0.05
17	1010	140	145	140	130	125	125	0.05
18	985	140	145	140	125	125	125	0.02
19	920	140	140	135	125	125	125	0.02
20	850	150	140	250	140	175	125	0.03

## Temperature and Pressure Readings

SECOND FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	21	22U	22L	23U	23L	24U	24L	25	
1	75	75	75	80	80	80	80	80	0.00
2	75	75	75	80	80	80	80	80	0.01
3	75	75	75	80	80	80	80	80	0.03
4	120	90	75	80	80	80	80	80	0.04
5	155	110	75	100	80	100	80	120	0.05
6	205	140	85	125	90	130	95	125	0.06
7	270	130	110	140	110	140	100	125	0.06
8	285	120	115	140	110	140	110	120	0.06
9	295	140	125	140	125	140	120	120	0.07
10	305	150	130	140	135	140	120	125	0.05
11	330	155	130	140	140	145	130	130	0.07
12	340	160	135	140	140	150	130	135	0.06
13	345	150	140	140	140	150	135	135	0.06
14	345	155	140	140	140	140	130	130	0.06
15	340	150	140	140	140	140	130	130	0.07
16	330	125	140	135	140	140	130	130	0.07
17	320	120	140	130	135	135	130	130	0.06
18	310	110	135	130	135	130	130	130	0.06
19	300	115	135	130	135	135	130	125	0.07
20	295	135	130	160	140	165	135	205	0.09

THIRD FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	31	32U	32L	33U	33L	34U	34L	35	
1	75	75	80	90	80	80	80	80	0.00
2	75	75	80	90	80	80	80	80	0.00
3	75	75	80	90	80	80	80	80	0.00
4	75	75	80	90	80	80	80	80	0.01
5	90	85	80	90	80	80	90	80	0.03
6	115	100	90	100	85	100	90	100	0.03
7	145	130	100	110	90	105	95	110	0.06
8	160	145	115	130	105	120	110	115	0.08
9	175	160	130	150	115	130	120	120	0.08
10	180	170	145	150	135	135	125	140	0.08
11	190	175	145	165	130	150	130	130	0.09
12	190	185	155	170	135	155	135	140	0.08
13	200	175	150	175	145	160	140	140	0.10
14	200	145	140	165	150	150	140	140	0.09
15	195	140	135	160	145	150	140	140	0.08
16	195	140	135	155	140	145	140	140	0.09
17	195	130	135	150	140	140	135	140	0.09
18	190	130	130	150	140	140	135	135	0.08
19	190	130	130	150	135	140	130	135	0.08
20	180	150	135	160	135	150	130	140	0.10

## Test C-2

**Date:** April 18, 1959

**Outdoor Temperature:** 67° F. **Humidity:** 60% **Wind:** 6 3  
m p h W Average

**Fuel:** 1,400 pounds of pallets with newspaper stuffed vertically  
in cracks in pallets to produce more smoke.

**Location of Test Fire:** Base of stairway No. 2

**Automatic Sprinklers:** Corridors and stairway openings

**Vents:** None

**Curtain Boards:** None

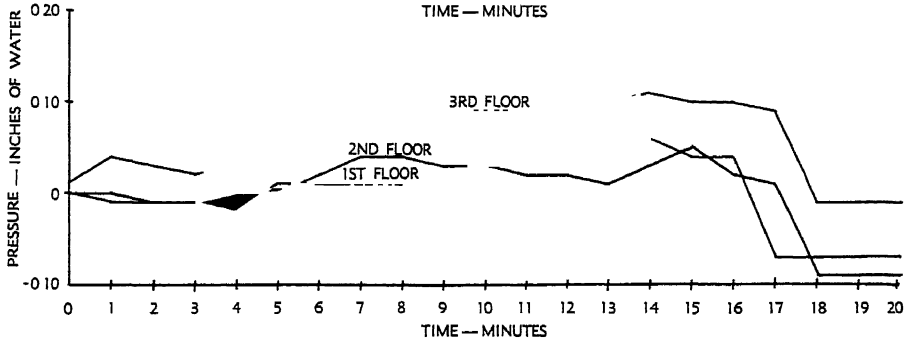
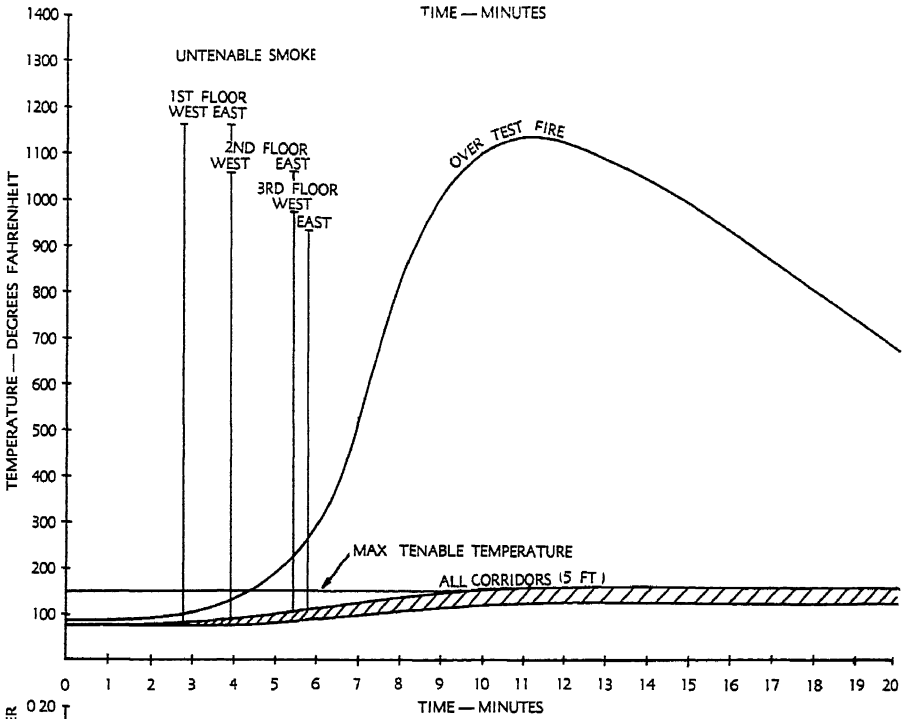
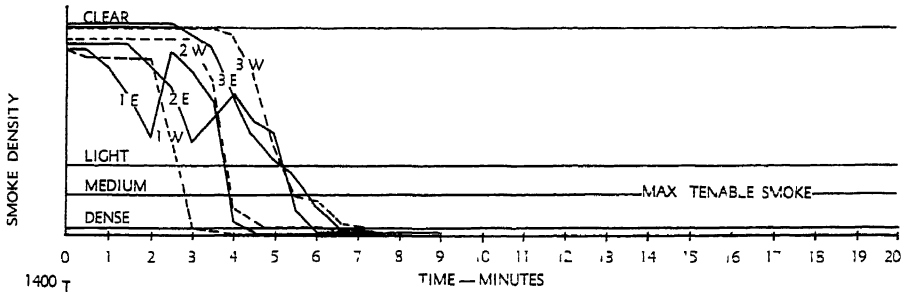
**Automatic Fire Detection:** None

**Other:** None

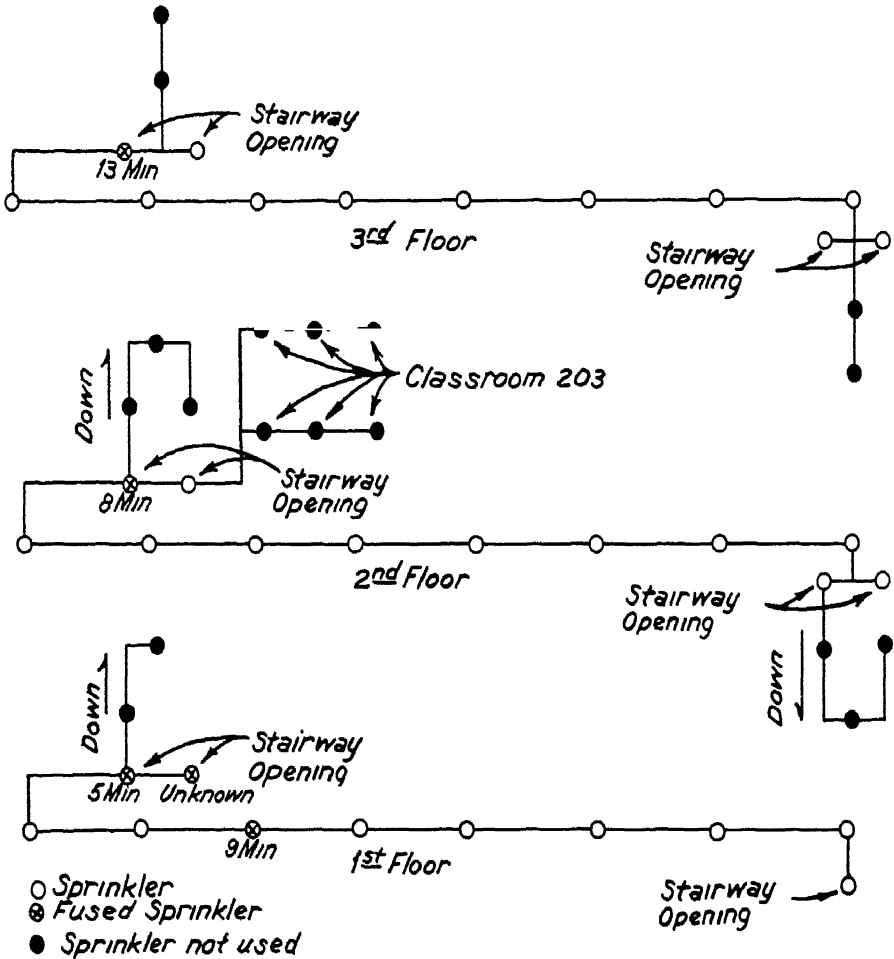
**Comments:**

First sprinkler opened after first floor corridor and west end of second floor corridor became untenable from smoke. Remainder of building filled with smoke before next head opened. Smoke did not clear even though 5 heads ultimately were operating.

Maximum tenable temperatures reached only in first floor corridor east, second floor corridor west and third floor corridor east.



## Automatic Sprinkler Operation



### Comments on Sprinkler Operation:

Sprinklers Utilized: corridors and stairway openings.

## Temperature and Pressure Readings

FIRST FLOOR								
Time Min- utes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11	12U	12L	13U	13L	14U	14L	
1	90	75	75	80	80	90	75	0.00
2	100	75	75	100	80	90	75	-0.01
3	100	105	75	110	80	90	75	-0.01
4	130	130	90	110	90	100	75	-0.02
5	200	140	105	120	90	100	95	0.01
6	290	140	115	130	100	120	95	0.01
7	530	120	130	140	110	135	115	0.01
8	850	250	145	180	140	150	130	0.01
9	1100	340	145	160	130	160	130	0.02
10	1060	335	140	150	130	150	125	0.03
11	1140	325	145	150	140	140	120	0.02
12	1140	350	150	150	140	140	120	0.02
13	1080	375	150	150	140	140	120	0.01
14	1030	375	150	150	140	140	130	0.03
15	990	340	150	140	140	140	130	0.05
16	910	285	145	140	130	140	125	0.02
17	900	295	145	140	130	140	125	0.01
18	780	265	140	135	130	135	125	-0.09
19	715	265	140	135	130	135	125	-0.09
20	700	250	130	130	125	130	120	-0.09

SECOND FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	21	22U	22L	23U	23L	24U	24L	25	
1	75	75	75	80	80	80	80	80	-0.01
2	75	75	75	80	80	80	80	80	-0.01
3	90	75	75	90	90	90	90	90	-0.01
4	100	75	75	90	90	90	90	100	0.00
5	125	75	75	90	90	90	90	100	0.00
6	100	100	75	100	90	100	90	115	0.02
7	200	110	80	120	100	120	100	120	0.04
8	275	145	115	130	100	130	110	140	0.04
9	290	130	125	130	120	140	120	140	0.03
10	300	130	130	140	130	140	120	130	0.03
11	305	135	130	140	130	140	130	130	0.03
12	310	145	135	140	130	140	130	130	0.04
13	310	150	140	140	140	150	130	130	0.05
14	315	140	140	140	140	150	140	140	0.06
15	305	140	140	140	140	150	140	140	0.04
16	280	140	135	140	140	150	140	140	0.04
17	310	135	140	140	140	150	140	140	-0.07
18	320	140	135	145	140	155	140	135	-0.07
19	315	135	130	150	140	160	140	130	-0.07
20	300	130	130	150	140	155	150	130	-0.07

## Temperature and Pressure Readings

THIRD FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	31	32U	32L	33U	33L	34U	34L	35	
1	75	75	80	80	80	80	80	80	0.04
2	75	75	90	90	90	90	90	90	0.03
3	75	75	90	90	90	90	90	90	0.02
4	75	75	90	90	90	90	90	90	0.03
5	80	80	90	90	90	90	90	90	0.03
6	80	80	90	90	90	90	90	90	0.05
7	120	110	100	100	90	95	90	100	0.06
8	140	125	110	110	100	110	100	110	0.08
9	155	135	120	120	100	110	110	130	0.09
10	165	150	120	130	110	120	115	120	0.09
11	165	155	130	140	120	130	120	130	0.09
12	175	160	140	150	130	140	130	130	0.09
13	175	150	150	150	140	140	130	140	0.10
14	160	135	130	150	130	140	130	130	0.11
15	160	125	130	140	130	140	130	140	0.10
16	150	125	130	130	120	140	130	140	0.10
17	140	120	120	130	120	130	130	130	0.09
18	135	125	130	140	130	140	140	140	-0.01
19	125	120	130	135	130	140	135	135	-0.01
20	125	120	130	130	130	130	130	135	-0.01

**Test C-3**

**Date:** April 18, 1959

**Outdoor Temperature:** 65° F   **Humidity:** 60%   **Wind:** 6 3  
m p h   W Average

**Fuel:** 1,400 pounds of solid pallets

**Location of Test Fire:** Base of stairway No 2

**Automatic Sprinklers:** Complete except heads shown as  
plugged on sprinkler data sheet

**Vents:** None

**Curtain Boards:** None

**Automatic Fire Detection:** None

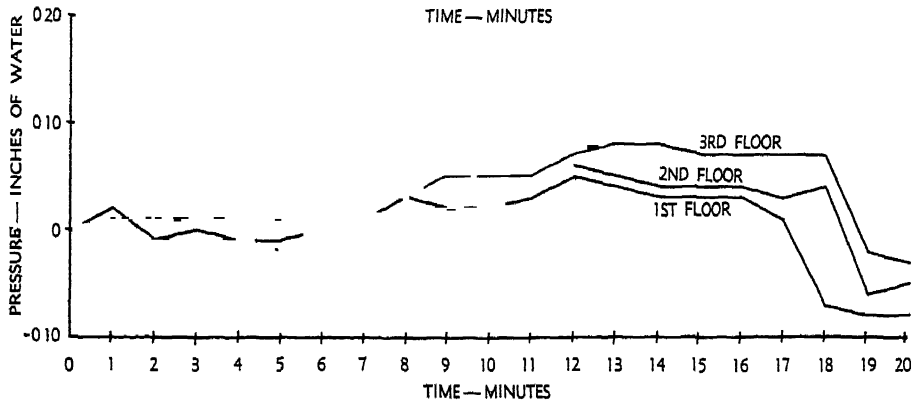
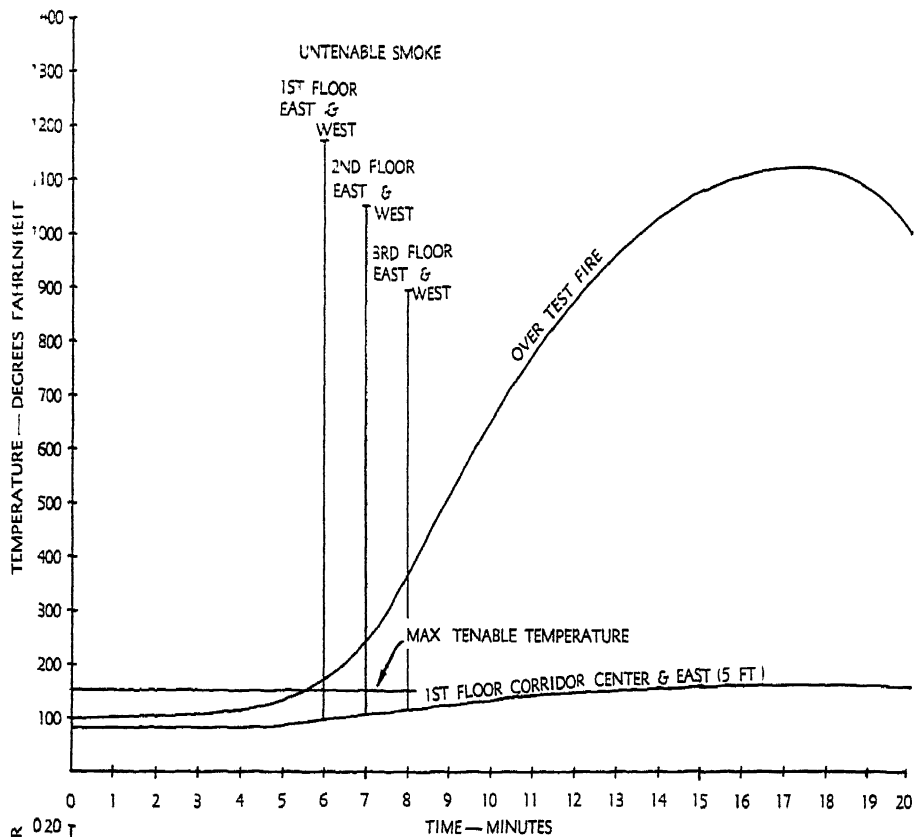
**Other:** No smoke density readings taken during this test   Smoke  
data from observers only.

**Comments:**

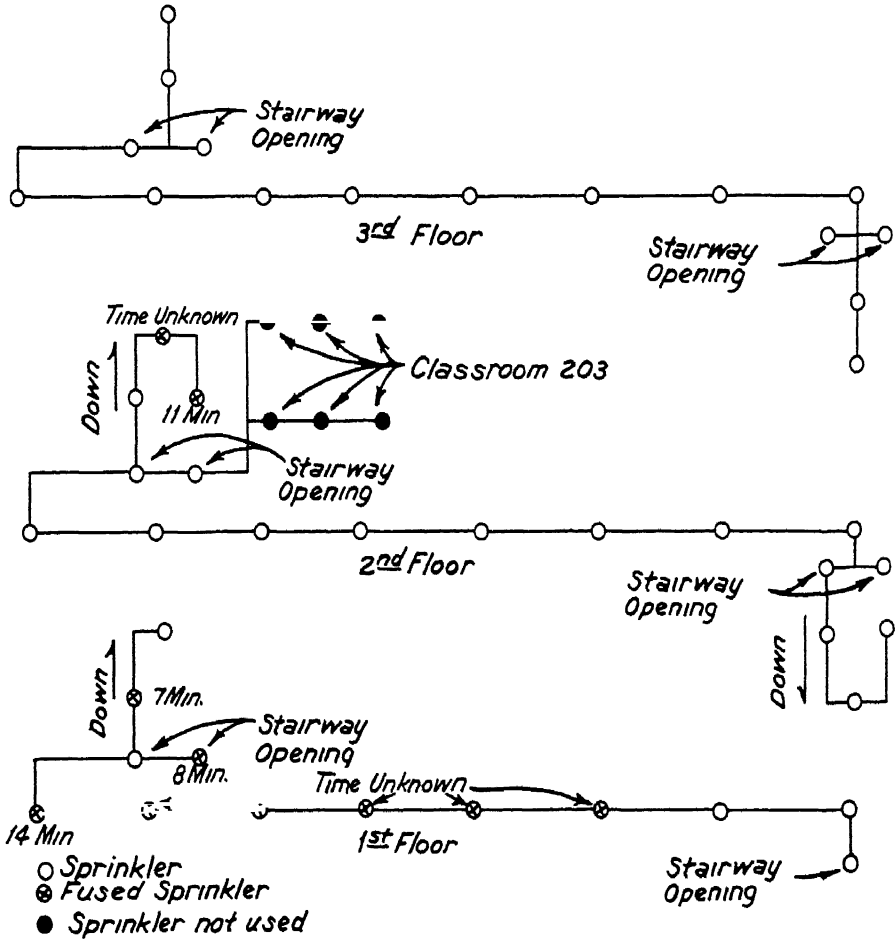
Test fire slow developing.

First and second floor corridors had untenable smoke  
conditions before any sprinkler operated

Corridor temperatures stayed low throughout the test.  
Maximum tenable temperatures reached only in first  
floor corridor in 13 minutes at the east end, 12 minutes at  
the center and 15 minutes on the west end.



## Automatic Sprinkler Operation



## Comments on Sprinkler Operation:

Sprinklers Utilized: corridors, stairway openings and stairways.

## Temperature and Pressure Readings

FIRST FLOOR								
Time Min- utes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11	12U	12L	13U	13L	14U	14L	
1	105	85	85	90	90	90	80	0.02
2	105	85	85	90	90	90	80	-0.01
3	115	90	85	90	90	90	80	0.00
4	115	90	85	90	90	90	85	-0.01
5	130	100	90	100	95	90	85	-0.01
6	165	105	90	105	100	95	85	0.00
7	270	125	90	120	110	100	95	0.01
8	550	160	100	150	130	115	110	0.02
9	590	190	125	160	150	130	130	0.02
10	620	165	130	145	145	135	130	0.02
11	725	175	135	150	145	140	130	0.03
12	865	140	145	155	150	150	135	0.05
13	915	145	150	160	150	150	145	0.04
14	1010	150	155	170	160	160	145	0.03
15	1055	150	160	170	160	155	150	0.03
16	1070	155	160	160	160	160	150	0.03
17	1130	150	155	160	155	155	150	0.01
18	1150	150	155	160	155	155	150	-0.07
19	1030	155	155	160	150	150	150	-0.08
20	1005	155	165	175	165	160	150	-0.08

SECOND FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	21	22U	22L	23U	23L	24U	24L	25	
1	90	80	80	90	85	90	90	90	-0.01
2	90	80	80	90	85	90	90	90	-0.01
3	90	85	80	90	85	90	90	90	-0.01
4	90	85	80	90	85	90	90	90	-0.01
5	95	85	80	90	85	95	90	95	-0.02
6	95	85	80	95	90	95	90	100	0.00
7	100	95	85	100	90	100	95	110	0.01
8	115	105	85	105	100	105	100	135	0.03
9	130	115	95	120	110	120	105	140	0.02
10	165	125	105	120	110	120	110	130	0.02
11	170	130	105	130	115	130	115	135	0.04
12	165	135	110	130	120	130	120	140	0.06
13	155	135	115	130	130	135	120	150	0.05
14	160	140	120	130	130	140	130	155	0.04
15	165	145	125	135	135	140	130	155	0.04
16	150	140	130	140	135	140	130	150	0.04
17	150	140	130	140	135	145	135	150	0.03
18	145	140	135	140	135	145	130	150	0.04
19	150	140	135	140	135	145	140	150	-0.06
20	150	140	130	140	135	150	130	165	-0.05

## Temperature and Pressure Readings

THIRD FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	31	32U	32L	33U	33L	34U	34L	35	
1	85	85	90	90	85	85	85	90	0.02
2	85	85	90	90	85	85	85	90	0.01
3	85	85	90	90	85	85	85	90	0.01
4	85	85	90	90	85	85	85	90	0.01
5	85	85	90	90	90	90	90	95	0.01
6	85	85	90	90	90	90	90	95	0.02
7	90	90	90	95	90	90	90	95	0.02
8	95	90	95	100	90	100	90	100	0.03
9	105	100	95	100	95	105	95	110	0.05
10	115	105	100	110	105	110	100	120	0.05
11	115	110	105	115	105	115	105	120	0.05
12	120	115	115	120	110	120	110	125	0.07
13	125	120	115	115	115	130	115	130	0.08
14	130	125	120	130	120	130	120	140	0.08
15	130	125	125	130	125	135	125	145	0.07
16	135	130	130	140	130	140	130	140	0.07
17	135	130	130	135	130	140	130	140	0.07
18	135	130	135	135	130	140	130	140	0.07
19	130	130	135	135	130	140	130	140	-0.02
20	125	130	130	135	130	140	130	140	-0.03

### Test C-4

**Date:** April 18, 1959

**Outdoor Temperature:** 64° F. **Humidity:** 60% **Wind:** 6 3  
m p h. W Average

**Fuel:** 1,400 pounds of pallets

**Location of Test Fire:** Classroom No. 103

**Automatic Sprinklers:** Complete as shown in Figure 11

**Vents:** None

**Curtain Boards:** None

**Automatic Fire Detection:** None

**Other:** Two windows in classroom No. 103 open 6 inches from bottom and two transoms in that room open to corridor  
No smoke density readings taken during this test. Smoke data from observers only

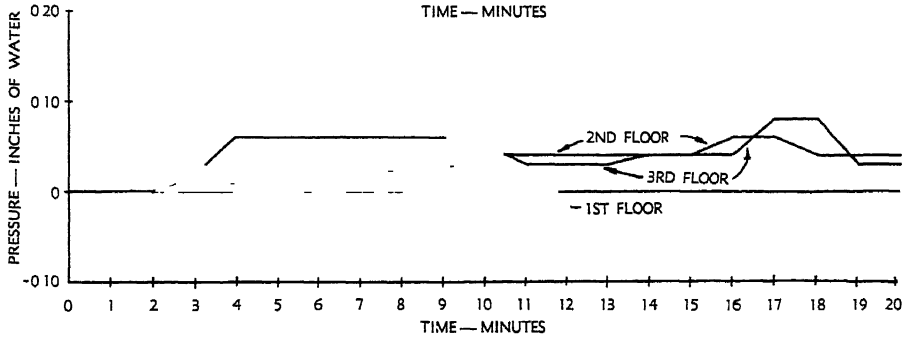
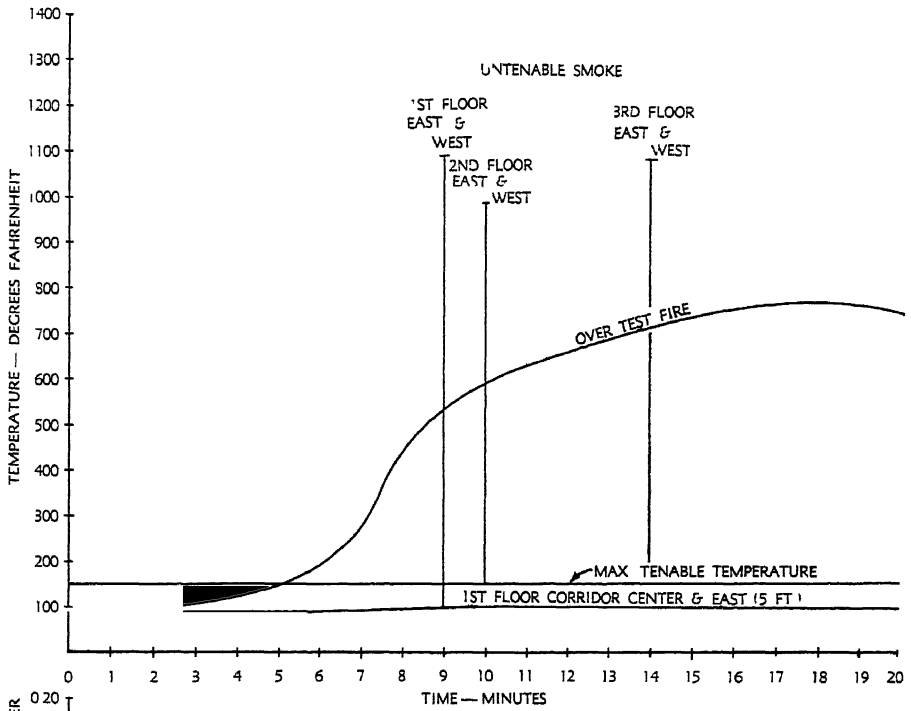
#### **Comments:**

Test fire very slow developing

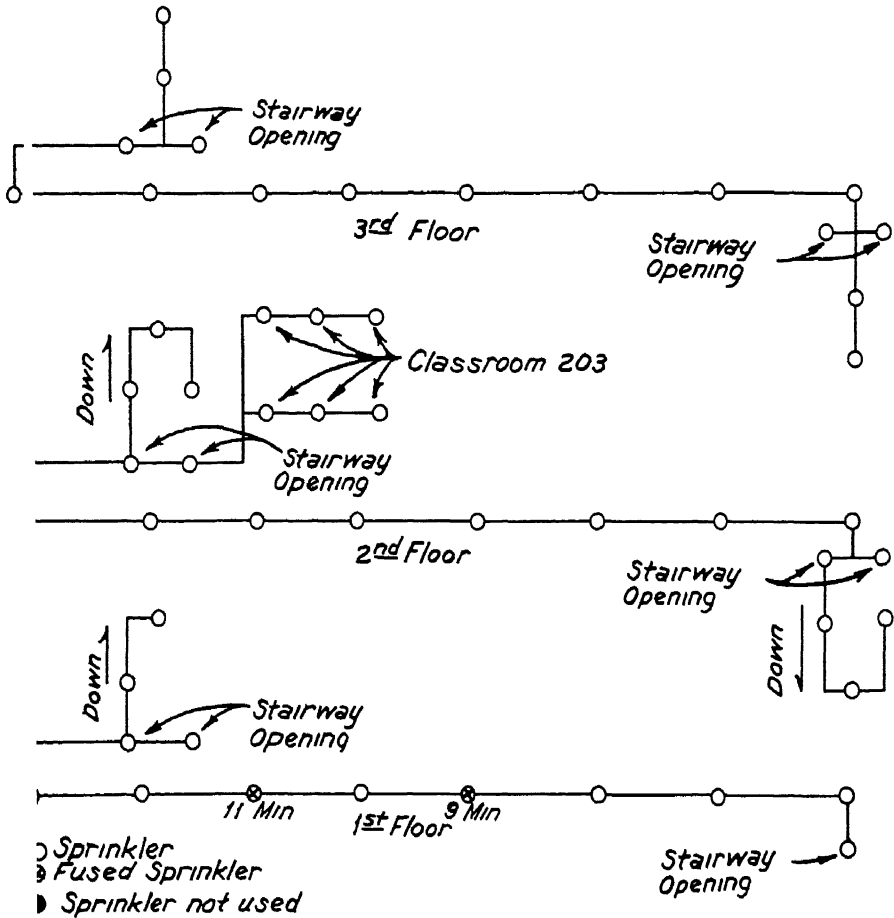
The first sprinkler operated in 9 minutes; the second head in 11 minutes

Untenable smoke conditions existed in all corridors at about the same time or soon after the operation of sprinklers

Maximum tenable temperature never reached at the 5 foot level in corridors.



## Automatic Sprinkler Operation



### Comments on Sprinkler Operation:

Sprinklers Utilized: complete system

All of the heads that operated were outside of Room 103 where the test fire was located.

# Temperature and Pressure Readings

FIRST FLOOR								
Time Min- utes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11 *	12U	12L	13U	13L	14U	14L	
1	95	90	90	95	90	90	85	0.00
2	95	90	90	95	90	90	85	0.00
3	100	90	90	100	90	95	85	0.00
4	130	90	90	100	95	95	85	0.00
5	150	90	90	100	95	100	85	0.00
6	170	95	95	105	95	100	90	0.00
7	290	100	95	105	100	100	90	0.00
8	330	110	95	105	100	100	90	0.00
9	600	125	100	105	100	100	90	0.00
10	620	140	105	105	100	100	90	0.00
11	640	125	100	105	100	100	95	0.00
12	610	110	100	105	100	100	90	0.00
13	660	100	100	105	100	100	90	0.00
14	750	100	100	105	100	100	90	0.00
15	690	100	100	105	100	100	90	0.00
16	710	100	100	105	100	100	90	0.00
17	730	100	100	105	100	100	90	0.00
18	830	100	100	105	100	100	90	0.00
19	750	100	100	105	100	100	90	0.00
20	750	100	100	105	100	100	90	0.00

\*Classroom 103

SECOND FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	21	22U	22L	23U	23L	24U	24L	25	
1	90	85	85	95	95	95	90	90	0.00
2	90	85	85	95	95	95	90	90	0.00
3	90	85	85	95	95	95	90	90	0.01
4	90	85	85	95	95	95	95	95	0.01
5	90	85	85	95	95	95	95	95	0.01
6	95	90	85	100	100	100	100	100	0.02
7	95	90	85	100	100	100	100	100	0.02
8	100	90	85	100	100	100	100	100	0.02
9	100	90	85	100	100	100	100	100	0.02
10	105	95	85	100	100	100	100	100	0.04
11	105	100	90	100	100	100	100	100	0.04
12	105	100	90	100	100	100	100	100	0.04
13	100	95	90	100	100	100	100	100	0.04
14	100	95	90	100	100	100	100	100	0.04
15	100	95	90	100	100	100	100	100	0.04
16	100	95	90	100	100	100	100	100	0.06
17	100	95	90	100	100	100	100	100	0.06
18	100	95	90	100	100	100	100	100	0.04
19	100	95	90	100	100	100	100	100	0.04
20	100	95	90	100	100	100	100	100	0.04

## Temperature and Pressure Readings

THIRD FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	31	32U	32L	33U	33L	34U	34L	35	
1	85	85	95	90	95	90	90	95	0.00
2	85	85	95	90	95	90	95	95	0.00
3	85	85	95	90	95	95	95	95	0.02
4	85	85	95	90	95	95	95	95	0.06
5	85	85	95	90	95	95	95	95	0.06
6	90	90	100	90	100	95	95	95	0.06
7	90	90	100	100	100	100	100	100	0.06
8	90	90	100	100	100	100	100	100	0.06
9	90	90	100	100	100	100	100	100	0.06
10	90	90	100	100	100	100	100	100	0.05
11	90	90	100	100	100	100	100	100	0.03
12	90	90	100	100	100	100	100	100	0.03
13	90	90	100	100	100	100	100	100	0.03
14	90	90	100	100	100	100	100	100	0.04
15	90	90	100	100	100	100	100	100	0.04
16	90	90	100	100	100	100	100	100	0.04
17	90	90	100	100	100	100	100	100	0.08
18	90	90	100	100	100	100	100	100	0.08
19	90	90	100	100	100	100	100	100	0.03
20	90	90	100	100	100	100	100	100	0.03

## Series D

### Vents and Sprinklers

This series of tests attempted to determine the effectiveness of vents with automatic sprinklers to control smoke and heat conditions in corridors. No sprinkler was located directly above the fire

#### Test D-1

**Date:** April 26, 1959

**Outdoor Temperature:** 68° F. **Humidity:** 68% **Wind:** 8.3 m.p.h. **W Average**

**Fuel:** 1,400 pounds of pallets

**Location of Test Fire:** Base of stairway No. 2

**Automatic Sprinklers:** Corridors and in stairways

**Vents:** 42 square feet at top of stairway No. 2

**Curtain Boards:** None

**Automatic Fire Detection:** Coverage as shown in Figure 12

**Other:** Vent opened 2 minutes after first sprinkler operated.  
Exit doors at west end of first floor corridor opened at the same time as vent.

#### Comments:

First and second floor corridors untenable from smoke before first sprinkler opened (7 minutes)

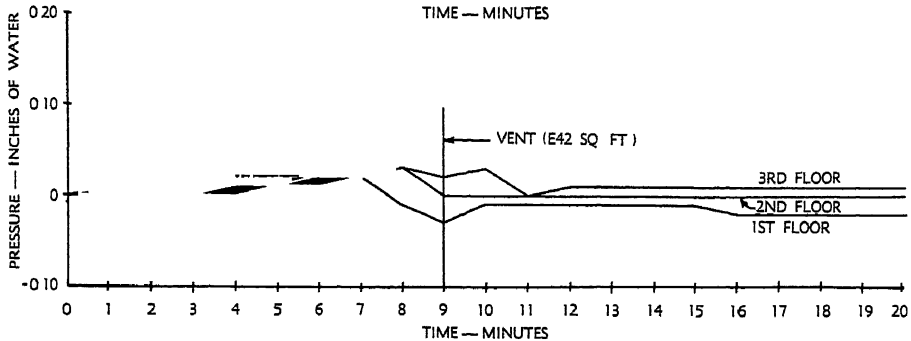
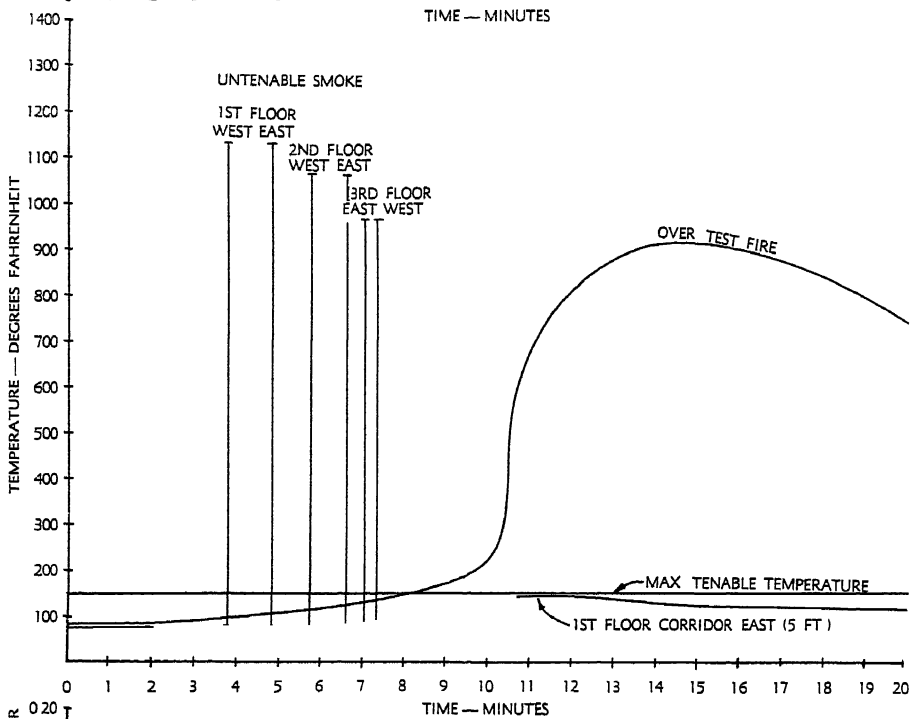
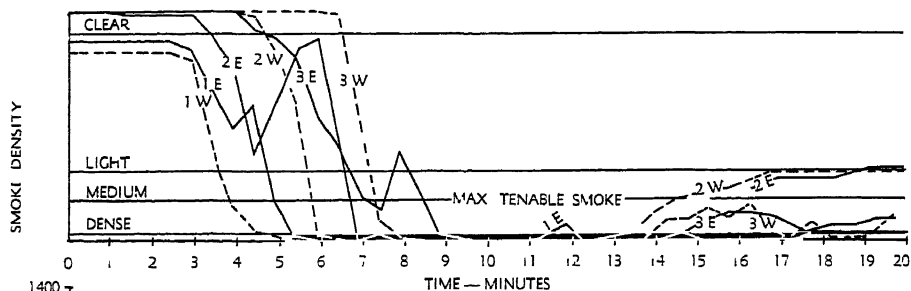
All corridors untenable from smoke before vent opened (9 minutes)

First and third floor corridors remained untenable from smoke in spite of operating sprinklers and an open vent.

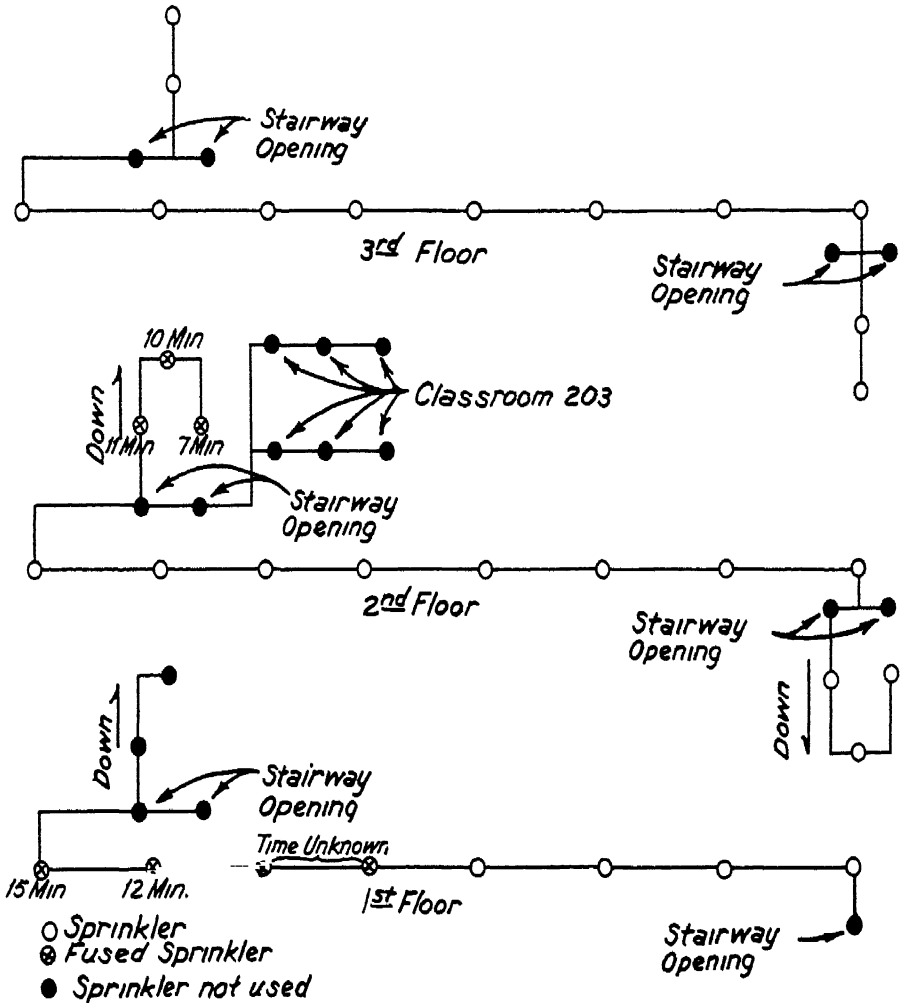
Maximum tenable temperatures at the 5 foot level reached only at east end of first floor corridor in 11 minutes and at center of second floor corridor in 17 minutes.

Vent failed to clear corridors of smoke.

Automatic fire detection equipment in first floor corridor operated 1 to 2 minutes before smoke conditions became untenable in that corridor.



## Automatic Sprinkler Operation



## Comments on Sprinkler Operation:

Sprinklers Utilized. corridors and stairways

## Automatic Fire Detection System

Circuit No.	Area Covered	Response Time from Fire Start	
		Minutes	Seconds
1	1st Floor Corridor	2	58
2	2nd Floor Corridor	6	50
3	3rd Floor Corridor	8	48
4	Room 203	9	40
5	Stairway No. 2	4	32
6	Stairway No. 1	5	2

## Temperature and Pressure Readings

FIRST FLOOR								
Time Min- utes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11	12U	12L	13U	13L	14U	14L	
1	85	85	75	85	85	85	75	0.01
2	85	85	75	85	85	85	75	0.01
3	90	85	75	85	90	85	75	0.01
4	100	90	80	90	90	90	80	0.02
5	110	105	80	90	90	90	80	0.02
6	120	125	85	100	90	95	80	0.02
7	140	170	85	125	100	105	85	0.02
8	160	145	100	130	110	120	95	-0.01
9	175	155	120	140	125	130	115	-0.03
10	200	185	130	155	125	135	125	-0.01
11	680	145	150	165	115	170	135	-0.01
12	825	205	135	170	110	165	130	-0.01
13	885	225	130	170	115	160	115	-0.01
14	920	280	130	180	110	165	120	-0.01
15	915	300	125	185	130	170	115	-0.01
16	890	275	120	145	130	165	120	-0.02
17	875	270	120	160	125	160	115	-0.02
18	840	275	120	150	130	155	115	-0.02
19	795	270	115	150	120	150	115	-0.02
20	740	265	120	150	120	150	105	-0.02

# Temperature and Pressure Readings

SECOND FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	21	22U	22L	23U	23L	24U	24L	25	
1	85	80	80	85	85	85	85	85	0.00
2	85	80	80	85	85	85	85	85	0.00
3	85	80	80	85	85	85	85	85	0.00
4	85	85	80	90	90	90	90	90	0.01
5	90	85	80	90	90	90	90	90	0.01
6	95	90	80	90	90	90	90	95	0.02
7	110	90	80	90	90	95	90	105	0.02
8	140	100	85	100	95	100	95	115	0.03
9	120	100	85	105	95	105	95	125	0.00
10	135	110	95	110	105	110	100	135	0.00
11	165	125	110	125	125	125	120	155	0.00
12	190	150	120	145	145	150	135	145	0.00
13	160	145	120	135	130	140	125	135	0.00
14	165	140	120	135	135	145	130	145	0.00
15	170	135	125	140	135	145	135	150	0.00
16	170	135	125	145	140	150	135	140	0.00
17	175	135	125	160	150	160	140	140	0.00
18	175	135	125	150	140	150	135	135	0.00
19	170	135	125	150	140	150	135	135	0.00
20	170	135	125	150	135	150	135	135	0.00

THIRD FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	31	32U	32L	33U	33L	34U	34L	35	
1	80	80	85	85	85	85	85	85	0.00
2	80	80	85	85	85	85	85	85	0.00
3	80	80	85	85	85	85	85	85	0.00
4	80	80	90	90	90	90	90	90	0.00
5	80	80	90	90	90	90	90	90	0.01
6	80	80	90	90	90	90	90	90	0.01
7	85	85	90	90	90	90	90	90	0.02
8	90	85	90	90	90	90	90	90	0.02
9	95	90	90	90	90	95	90	100	0.02
10	95	95	95	100	95	110	100	110	0.03
11	105	100	105	110	105	120	115	120	0.00
12	115	110	115	120	115	120	120	125	0.01
13	115	110	115	120	115	120	120	120	0.01
14	115	115	120	120	120	125	125	130	0.01
15	120	115	125	125	125	130	125	135	0.01
16	120	120	125	125	125	130	130	135	0.01
17	120	120	135	125	125	130	125	135	0.01
18	120	120	125	125	125	130	125	135	0.01
19	125	120	125	125	125	130	125	130	0.01
20	125	120	125	125	125	130	125	130	0.01

## Test D-2

**Date:** April 26, 1959

**Outdoor Temperature:** 69° F   **Humidity:** 68%   **Wind:** 8 3  
m p h. W Average

**Fuel:** 1,400 pounds of pallets

**Location of Test Fire:** Base of stairway No. 2

**Automatic Sprinklers:** Corridors only

**Vents:** 42 square feet at top of stairway No. 2

**Curtain Boards:** None

**Automatic Fire Detection:** Coverage as shown in Figure 12

**Other:** Vent opened 5 minutes after first sprinkler operated.  
Exit doors at west end of first floor corridor opened at the  
same time as vent.

### Comments:

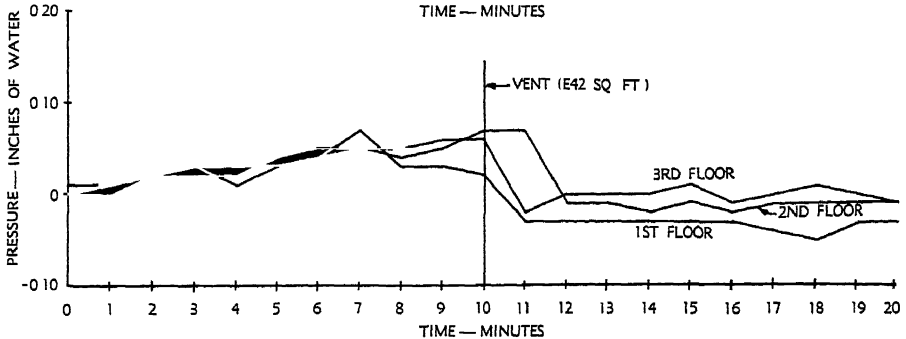
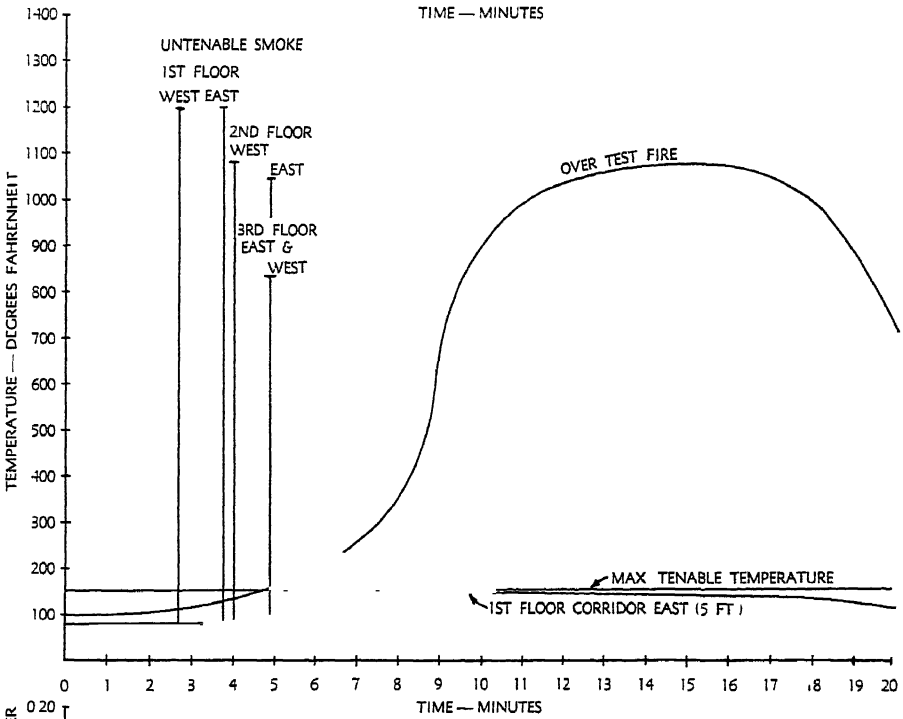
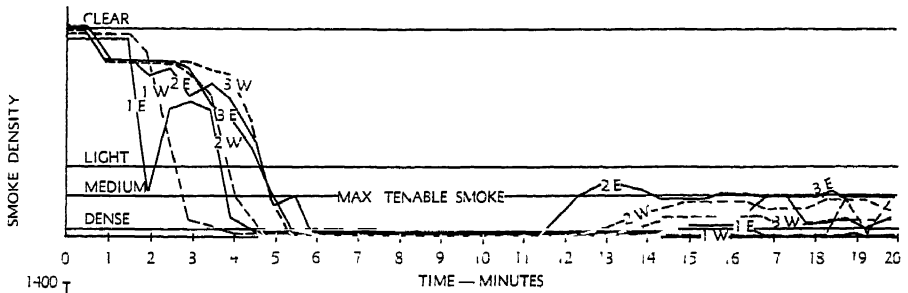
First and second floor corridors untenable from smoke before first sprinkler operated. Third floor corridor untenable from smoke about the same time first sprinkler operated.

Untenable smoke conditions did not clear even though 8 sprinklers were operating

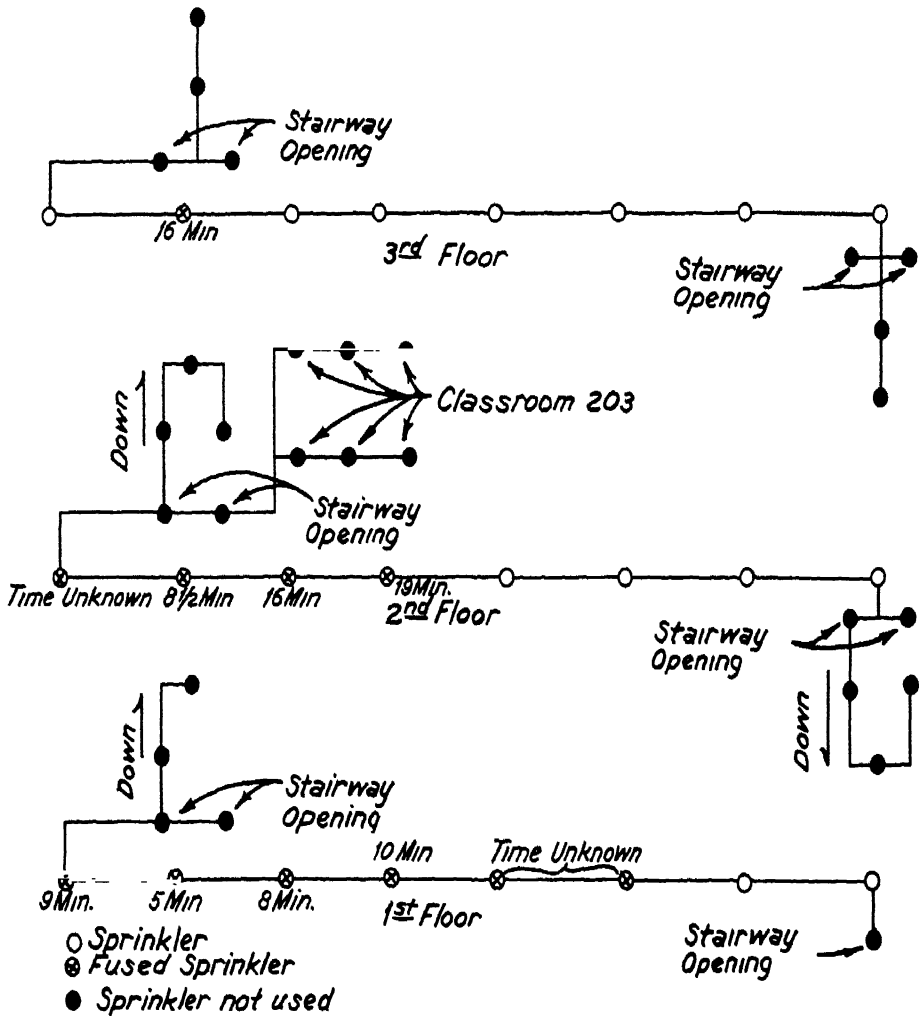
Vent opened in 10 minutes and failed to clear smoke from corridors.

Maximum tenable temperatures reached at 5 foot level at east end of first floor corridor in 10 minutes; at the west end in 8 to 9 minutes. On the second floor corridor maximum tenable temperatures were reached at the center in 13 minutes; at the west end in 15 minutes

Operation of the automatic fire detection equipment (Circuit No. 1) occurred at about the same time as untenable smoke conditions in the first floor corridor



## Automatic Sprinkler Operation



## Comments on Sprinkler Operation:

Sprinklers Utilized: corridors only.

## Automatic Fire Detection System

Circuit No.	Area Covered	Response Time from Fire Start	
		Minutes	Seconds
1	1st Floor Corridor	3	25
2	2nd Floor Corridor	5	35
3	3rd Floor Corridor	7	17
4	Room 203	7	26
5	Stairway No. 2	3	50
6	Stairway No. 1	4	52

## Temperature and Pressure Readings

FIRST FLOOR								
Time Min- utes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11	12U	12L	13U	13L	14U	14L	
1	100	90	80	90	90	95	85	0.01
2	100	95	80	90	90	95	85	0.02
3	115	110	85	100	95	100	90	0.03
4	135	130	85	110	95	105	95	0.03
5	155	205	95	130	105	120	100	0.03
6	200	225	120	135	110	135	115	0.04
7	250	255	135	145	125	140	125	0.07
8	320	335	140	160	135	145	140	0.03
9	740	340	145	165	145	160	155	0.03
10	920	350	150	155	140	160	145	0.02
11	1025	375	150	160	135	160	140	-0.03
12	1035	330	150	145	120	160	135	-0.03
13	1050	330	135	140	115	155	125	-0.03
14	1060	315	140	150	115	155	120	-0.03
15	1055	325	135	150	110	155	120	-0.03
16	1055	355	145	165	130	160	130	-0.03
17	1115	345	135	145	135	160	115	-0.04
18	1015	295	125	130	125	145	105	-0.05
19	860	290	120	140	125	145	105	-0.03
20	725	270	115	135	120	140	100	-0.03

## Temperature and Pressure Readings

SECOND FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	21	22U	22L	23U	23L	24U	24L	25	
1	90	85	80	90	90	90	90	95	0.01
2	85	85	80	90	90	90	90	95	0.02
3	95	85	80	90	90	90	90	100	0.02
4	105	90	80	95	90	95	90	105	0.02
5	125	95	80	100	95	100	95	125	0.04
6	170	115	85	115	100	120	100	125	0.05
7	215	125	95	140	125	140	110	135	0.05
8	255	120	110	145	115	150	110	140	0.04
9	240	125	120	140	120	145	120	155	0.05
10	315	130	130	140	125	150	125	145	0.07
11	325	135	135	150	140	160	135	145	0.07
12	345	135	140	175	145	175	140	145	-0.01
13	325	135	140	175	150	180	145	145	-0.01
14	325	130	135	185	150	185	145	145	-0.02
15	335	130	135	165	130	180	150	150	-0.01
16	380	125	135	155	135	170	150	150	-0.02
17	360	135	140	160	130	170	150	145	-0.01
18	300	130	135	155	130	175	150	135	-0.01
19	345	125	130	140	125	165	145	135	-0.01
20	305	115	125	125	120	155	140	130	-0.01

THIRD FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	31	32U	32L	33U	33L	34U	34L	35	
1	85	85	90	90	90	90	90	90	0.00
2	85	85	90	90	90	90	90	95	0.02
3	85	85	90	90	90	90	90	95	0.03
4	85	85	90	90	90	90	90	100	0.01
5	90	90	90	90	90	95	90	105	0.03
6	100	100	95	100	95	100	95	115	0.04
7	115	115	105	110	100	110	105	120	0.05
8	130	125	105	120	105	110	110	125	0.05
9	145	140	115	130	110	120	115	130	0.06
10	160	160	130	145	120	135	125	140	0.06
11	160	170	140	155	130	140	130	145	-0.02
12	155	175	140	160	135	145	135	150	0.00
13	170	185	145	160	140	145	140	150	0.00
14	170	185	145	160	145	150	145	145	0.00
15	170	180	145	155	145	145	145	145	0.01
16	170	180	145	160	145	145	140	145	-0.01
17	165	155	140	155	140	145	140	150	0.00
18	160	140	135	145	135	145	140	140	0.01
19	155	135	135	140	135	140	140	135	0.00
20	145	130	130	135	130	135	130	135	-0.01

**Test D-3**

**Date:** April 26, 1959

**Outdoor Temperature:** 71° F   **Humidity:** 65%   **Wind:** 8 3  
m p h   W Average

**Fuel:** 2,000 pounds of pallets

**Location of Test Fire:** Classroom No 103

**Automatic Sprinklers:** Corridors only

**Vents:** 42 square feet at top of stairway No. 2, 42 square feet at  
top of stairway No 1

**Curtain Boards:** None

**Automatic Fire Detection:** Coverage as shown in Figure 12

**Other:** Vents opened when first sprinkler operated   Two exterior windows in classroom No 103 open 1 foot from the bottom and two transoms between that room and the corridor open

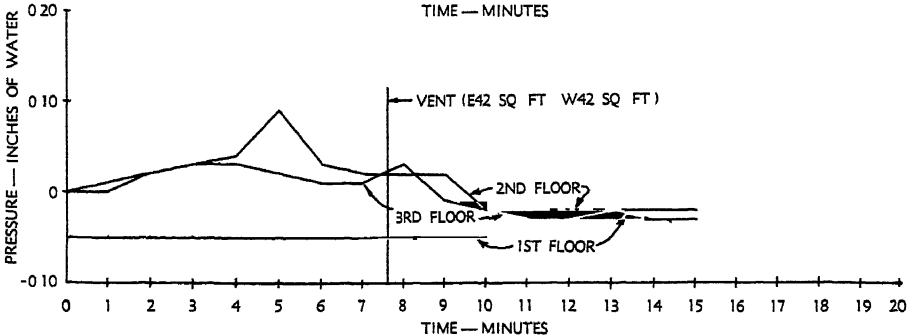
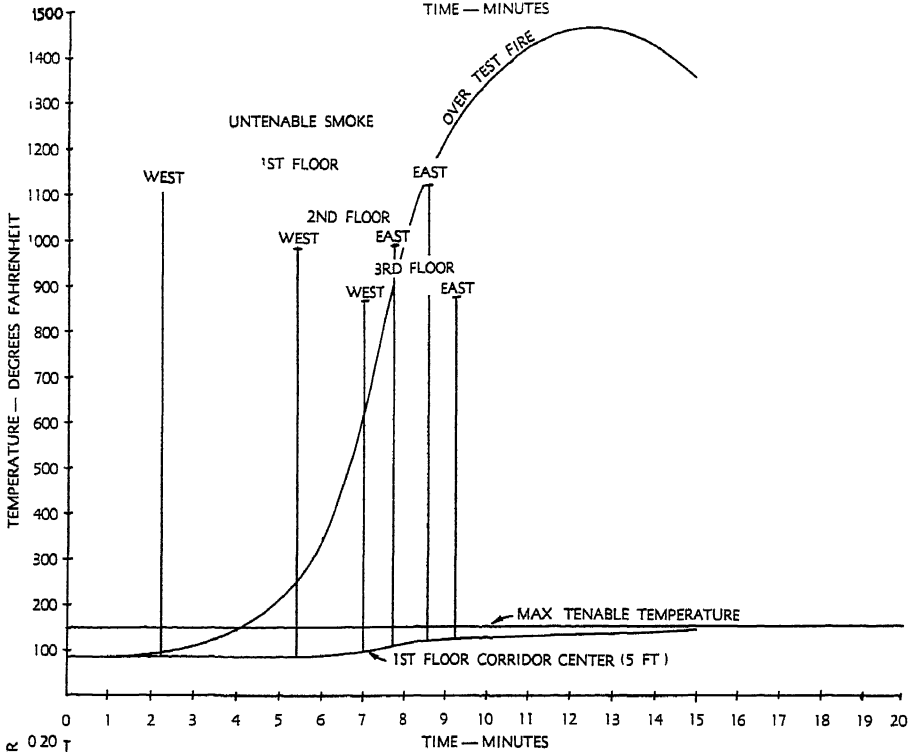
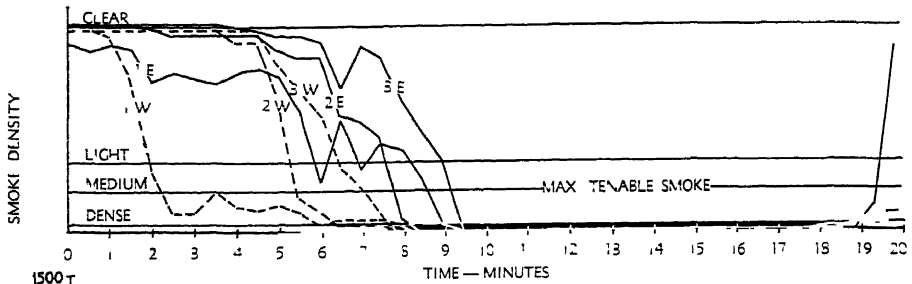
**Comments:**

Vents did not clear smoke from corridors.

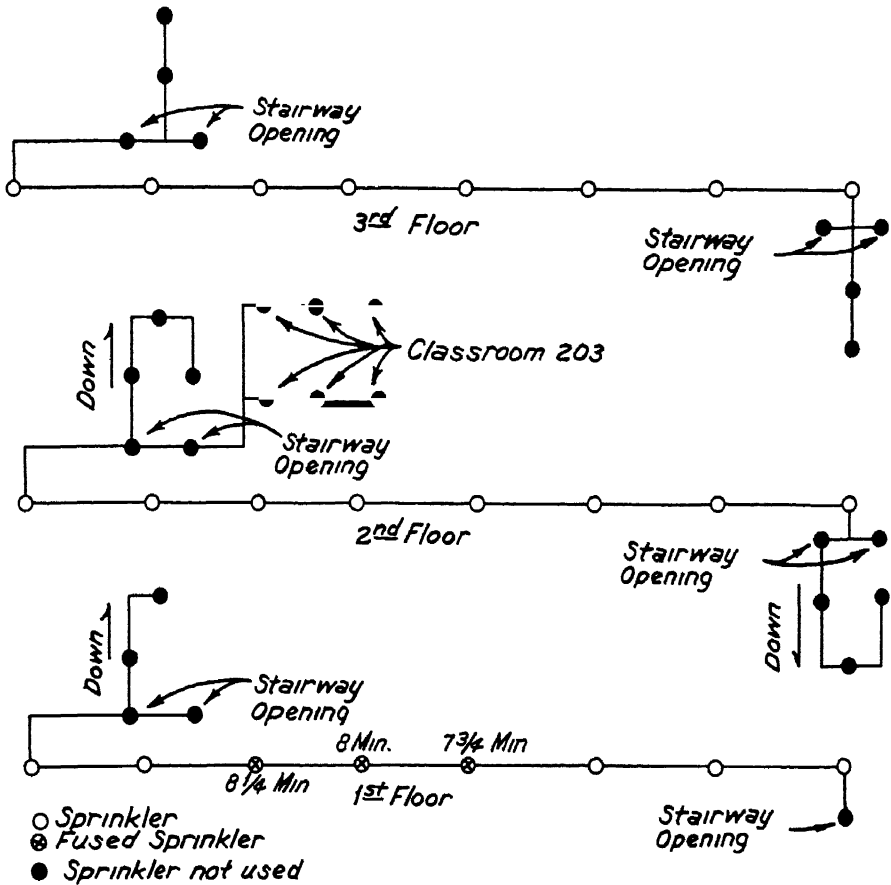
Sprinklers kept temperatures down in the corridors. Maximum tenable temperature not reached at any thermocouple at the 5 foot level in the corridors except the center of the first floor

All corridors untenable from smoke 9 minutes after start of test fire

First sprinkler head opened in  $7\frac{3}{4}$  minutes



## Automatic Sprinkler Operation



## Comments on Sprinkler Operation:

Sprinklers Utilized: corridors only.

## Automatic Fire Detection System

Circuit No.	Area Covered	Response Time from Fire Start	
		Minutes	Seconds
1	1st Floor Corridor	4	18
2	2nd Floor Corridor	9	50
3	3rd Floor Corridor	No response.	
4	Room 203	No response.	
5	Stairway No. 2	7	22
6	Stairway No. 1	7	40

## Temperature and Pressure Readings

FIRST FLOOR								
Time Min- utes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11*	12U	12L	13U	13L	14U	14L	
1	90	90	85	90	90	90	80	-0.05
2	100	90	85	90	90	95	80	-0.05
3	115	90	85	90	90	95	80	-0.05
4	150	90	85	95	90	95	85	-0.05
5	210	95	85	105	90	95	85	-0.05
6	350	100	85	125	90	105	85	-0.05
7	630	120	85	165	95	125	80	-0.05
8	1025	150	90	145	115	140	90	-0.05
9	1225	130	90	145	120	140	105	-0.05
10	1340	125	95	145	130	145	115	-0.05
11	1480	135	90	155	135	145	120	-0.04
12	1415	135	90	150	135	155	120	-0.03
13	1400	140	90	150	130	150	120	-0.03
14	1465	145	95	120	140	165	120	-0.03
15	160	140	90	145	150	160	135	-0.03
16								
17								
18								
19								
20								

\*Classroom 103



### Test D-4

**Date:** April 26, 1959

**Outdoor Temperature:** 69° F   **Humidity:** 65%   **Wind:** 8.3 m p h. W Average

**Fuel:** 1,400 pounds of pallets. Solid pallets on top of stack and at the sides.

**Location of Test Fire:** Classroom No 203

**Automatic Sprinklers:** Corridors and classroom No. 203

**Vents:** 42 square feet at top of stairway No. 2; 42 square feet at top of stairway No. 1

**Curtain Boards:** None

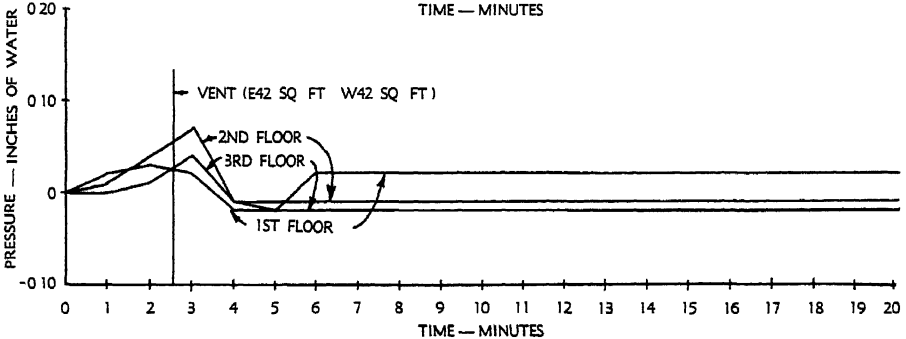
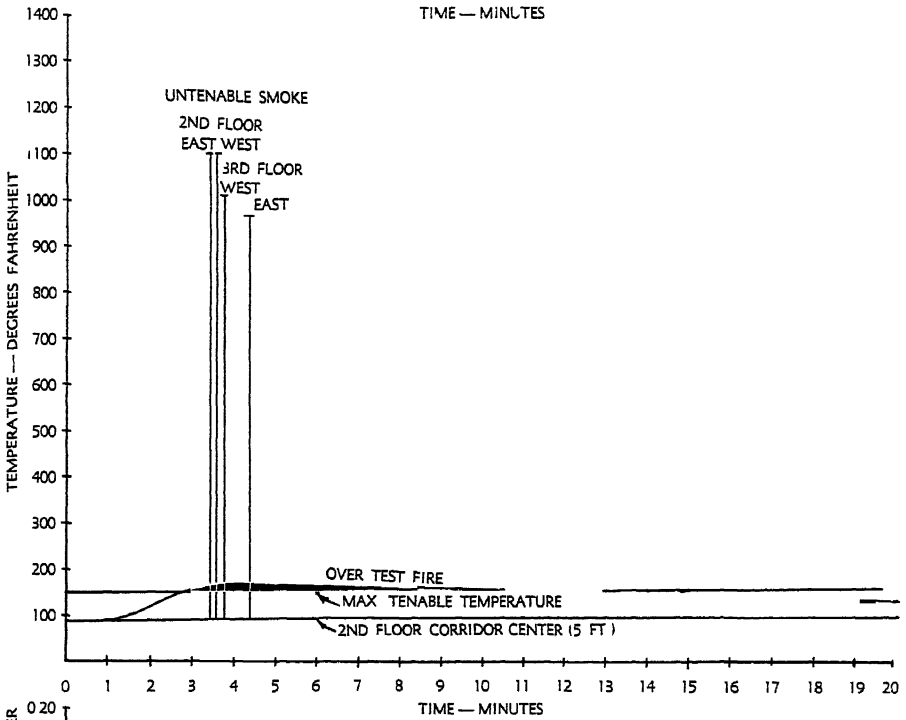
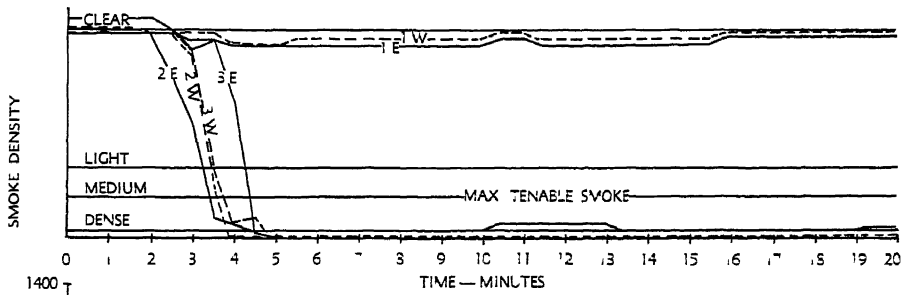
**Automatic Fire Detection:** Coverage as shown in Figure 12

**Other:** Vents opened at operation of first sprinkler Two exterior windows in classroom No 203 open one foot from the bottom and four transoms between that room and the corridor open.

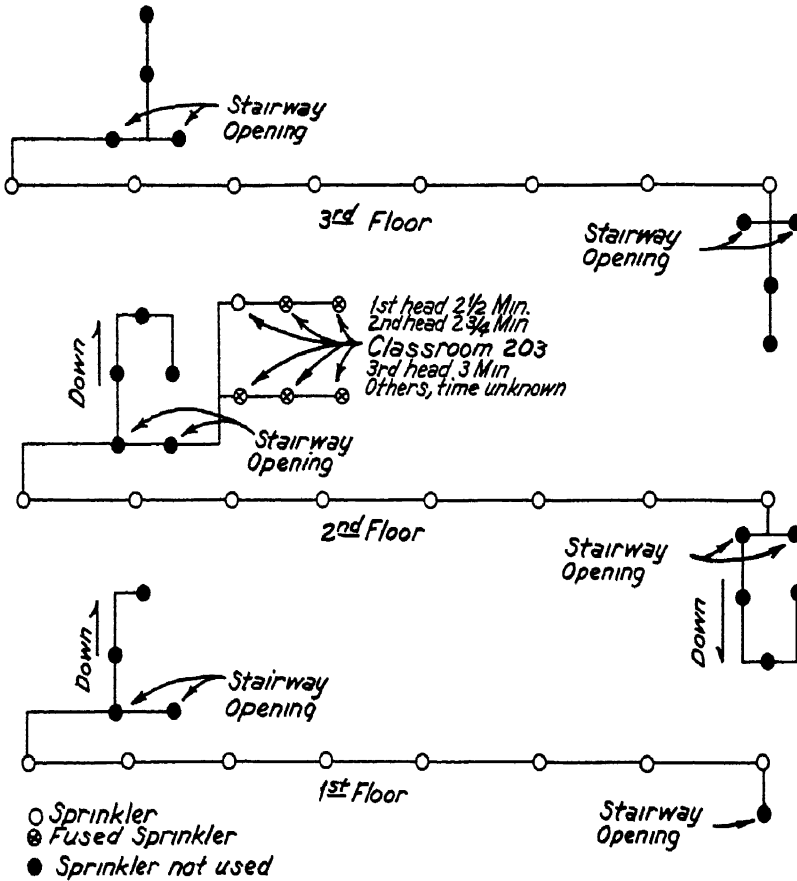
**Comments:**

Five sprinklers operated in classroom No. 203 but solid pallets around and on top of test fire shielded it so that sprinklers could not extinguish the fire, only hold it in check. First sprinkler opened in 2½ minutes

Second and third floor corridors became untenable from smoke after sprinklers in classroom No 203 operated and stayed untenable during the entire test.



## Automatic Sprinkler Operation



## Comments on Sprinkler Operation:

Sprinklers Utilized corridors and Room 203.

## Automatic Fire Detection System

Circuit No.	Area Covered	Response Time from Fire Start	
		Minutes	Seconds
1	1st Floor Corridor	No response	
2	2nd Floor Corridor	2	40
3	3rd Floor Corridor	No response	
4	Room 203	2	0
5	Stairway No. 2	No response.	
6	Stairway No 1	3	2

## Temperature and Pressure Readings

FIRST FLOOR								
Time Min- utes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11 *	12U	12L	13U	13L	14U	14L	
1	90	85	85	90	90	90	85	0.02
2	115	85	85	90	90	95	85	0.03
3	170	85	85	90	90	95	85	0.02
4	170	85	85	90	90	95	85	-0.02
5	170	85	85	90	90	95	85	-0.02
6	150	85	85	90	90	95	85	-0.02
7	160	85	85	90	90	95	85	-0.02
8	160	85	85	90	90	90	85	-0.02
9	160	85	85	90	90	95	85	-0.02
10	160	85	85	90	90	90	85	-0.02
11	160	85	85	90	90	90	85	-0.02
12	160	85	85	90	90	90	85	-0.02
13	160	85	85	90	90	90	85	-0.02
14	155	85	85	90	90	90	85	-0.02
15	155	85	85	90	90	90	85	-0.02
16	150	85	85	90	90	90	85	-0.02
17	150	80	80	90	90	90	85	-0.02
18	130	80	80	90	90	90	85	-0.02
19	130	80	80	90	90	90	85	-0.02
20	130	80	80	90	90	90	80	-0.02

\*Classroom 203

## Temperature and Pressure Readings

SECOND FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	21	22U	22L	23U	23L	24U	24L	25	
1	90	85	80	90	90	90	90	90	0.01
2	90	85	85	90	90	90	90	90	0.04
3	90	100	85	110	90	110	90	90	0.07
4	90	110	90	115	90	115	90	90	-0.01
5	90	115	90	115	90	115	90	90	-0.01
6	90	115	90	115	95	120	95	90	-0.01
7	90	120	90	120	95	125	95	90	-0.01
8	85	120	85	120	90	125	95	90	-0.01
9	85	120	90	120	90	125	95	90	-0.01
10	85	125	90	125	95	125	95	90	-0.01
11	85	125	90	125	95	125	95	90	-0.01
12	90	125	90	125	90	125	95	90	-0.01
13	90	120	90	125	90	125	95	90	-0.01
14	90	120	100	120	90	125	95	90	-0.01
15	85	120	95	120	95	125	100	90	-0.01
16	85	120	95	120	95	120	100	90	-0.01
17	85	125	90	115	95	120	100	90	-0.01
18	85	115	90	115	95	120	100	90	-0.01
19	85	110	90	110	95	115	100	90	-0.01
20	85	110	90	110	95	115	95	90	-0.01

THIRD FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	31	32U	32L	33U	33L	34U	34L	35	
1	85	80	90	90	90	90	90	90	0.00
2	85	85	90	90	90	90	90	90	0.01
3	85	85	90	90	90	90	90	95	0.04
4	90	90	90	90	90	90	90	100	-0.01
5	90	90	90	90	90	95	90	100	-0.02
6	90	90	90	90	90	95	90	100	-0.02
7	90	90	90	90	90	95	90	100	-0.02
8	90	95	90	90	90	100	90	95	-0.02
9	90	95	95	95	95	95	95	100	-0.02
10	90	95	95	95	95	100	95	100	-0.02
11	90	100	95	95	95	100	95	95	-0.02
12	90	100	100	100	95	100	95	100	-0.02
13	90	100	95	100	95	100	95	95	-0.02
14	90	95	90	90	90	95	90	95	-0.02
15	95	95	95	95	95	100	95	100	-0.02
16	90	95	90	90	90	100	90	95	-0.02
17	90	95	95	95	90	95	90	95	-0.02
18	90	95	90	95	95	100	95	95	-0.02
19	90	95	90	95	90	95	95	95	-0.02
20	85	90	90	95	95	95	95	95	-0.02

## Series E

### Vents and Curtain Boards — Winter Conditions

The effectiveness of combinations of vents and curtain boards was the purpose of this series of tests. The entire series was conducted to simulate winter conditions when exterior openings in the building would normally be closed.

#### Test E-1

**Date:** April 19, 1959

**Outdoor Temperature:** 63° F. **Humidity:** 63% **Wind:** 5.8 m.p.h. W Average

**Fuel:** 1,400 pounds of pallets

**Location of Test Fire:** Base of stairway No. 2

**Automatic Sprinklers:** None

**Vents:** 21 square feet above stairway No. 2, 21 square feet above stairway No. 1

**Curtain Boards:** Corridors only

**Automatic Fire Detection:** Coverage as shown in Figure 12

**Other:** Vents actuated by fusible links rated at 165 degrees Fahrenheit

#### Comments:

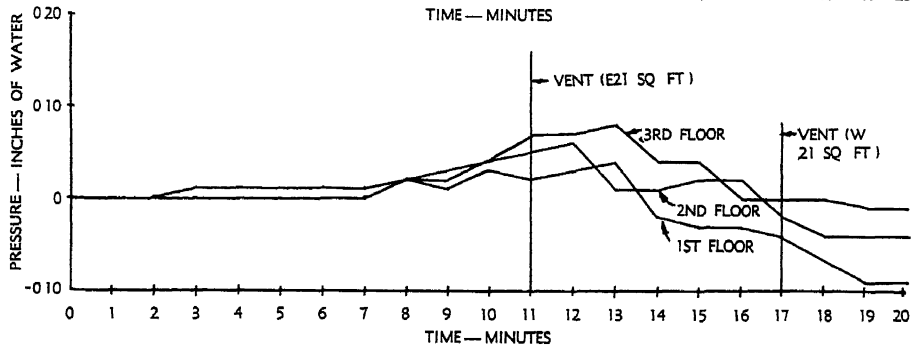
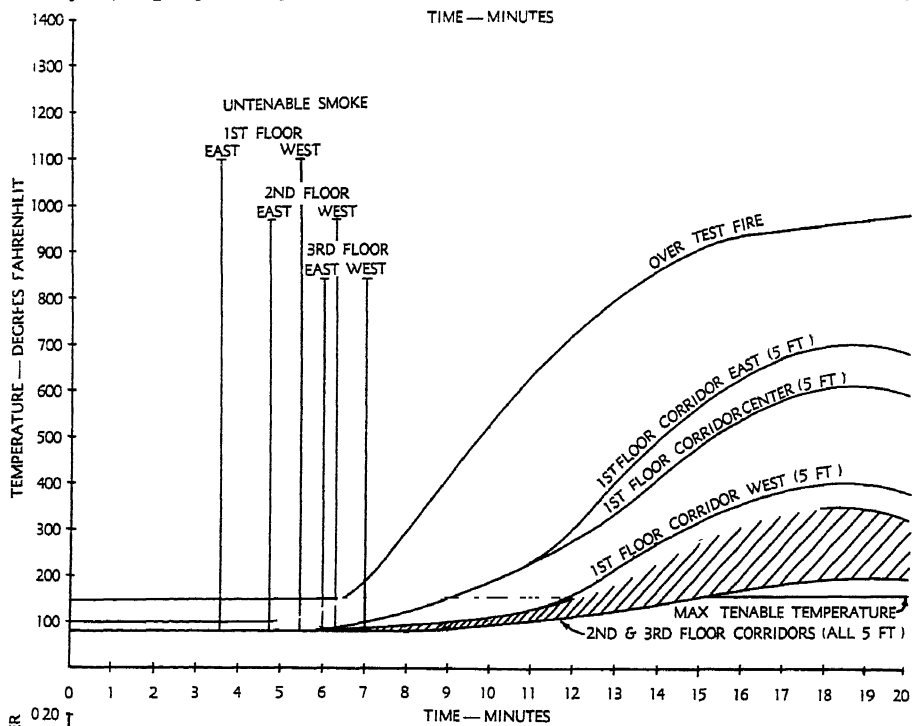
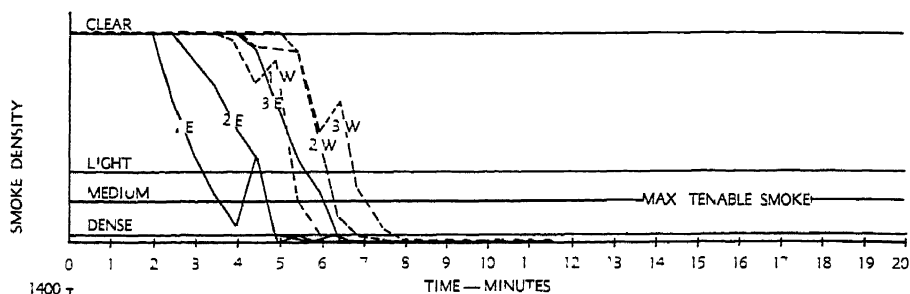
All corridors became untenable from smoke at the end of 7 minutes

Fusible links did not operate until 11 minutes over stairway No. 2 and 17 minutes over stairway No. 1

Vents failed to clear corridors of heat and smoke. Vents did not reach maximum effectiveness until 19 minutes after start of test fire

Curtain boards delayed the spread of smoke from the east to the west end of the first and second floor corridors but had no effect on smoke spread in the third floor corridor.

Curtain boards effectively delayed heat spread through the building as evidenced by the temperatures at the thermocouples.



## Automatic Fire Detection System

Circuit No.	Area Covered	Response Time from Fire Start	
		Minutes	Seconds
1	1st Floor Corridor	13	3
2	2nd Floor Corridor	13	54
3	3rd Floor Corridor	12	56
4	Room 203	5	46
5	Stairway No 2	3	11
6	Stairway No 1	12	36

## Temperature and Pressure Readings

FIRST FLOOR								
Time Min- utes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11	12U	12L	13U	13L	14U	14L	
1	100	80	75	85	80	85	70	0.00
2	100	80	75	85	80	85	70	0.00
3	100	80	75	85	80	85	70	0.01
4	100	80	75	85	80	85	70	0.01
5	100	80	75	85	80	85	70	0.01
6	120	95	75	95	85	85	70	0.01
7	190	125	85	100	95	85	75	0.01
8	320	205	105	130	120	90	75	0.02
9	425	280	145	180	150	105	85	0.01
10	520	340	175	230	185	120	105	0.03
11	590	415	220	280	230	145	125	0.02
12	645	465	260	320	260	170	150	0.03
13	710	645	420	350	300	180	210	0.04
14	905	720	505	460	440	255	285	-0.02
15	930	765	560	515	505	325	320	-0.03
16	930	795	625	560	550	365	340	-0.03
17	940	790	675	575	580	395	370	-0.04
18	960	803	685	580	595	385	380	-0.09
19	970	760	675	585	595	420	390	-0.09
20	985	760	695	585	600	385	395	-0.09

## Temperature and Pressure Readings

SECOND FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	21	22U	22L	23U	23L	24U	24L	25	
1	75	75	75	80	80	80	80	80	0.00
2	75	75	75	80	80	80	80	80	0.00
3	75	75	75	80	80	80	80	80	0.00
4	75	75	75	80	80	80	80	80	0.00
5	75	75	75	80	80	80	80	80	0.00
6	80	80	75	80	80	80	80	80	0.00
7	95	85	75	85	85	85	85	85	0.00
8	125	100	85	95	95	90	80	80	0.02
9	165	130	100	110	105	100	85	85	0.03
10	200	135	115	135	120	120	90	100	0.04
11	240	185	135	160	145	140	100	115	0.05
12	280	225	160	185	170	155	115	125	0.06
13	330	250	180	195	185	170	120	140	0.01
14	410	305	235	240	225	200	140	215	0.01
15	455	350	280	280	265	240	170	255	0.02
16	495	375	315	310	290	265	200	285	0.02
17	510	390	325	335	310	280	210	305	-0.02
18	530	400	335	350	330	285	230	315	-0.04
19	540	405	325	355	335	290	255	335	-0.04
20	540	395	320	355	335	290	260	340	-0.04

THIRD FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	31	32U	32L	33U	33L	34U	34L	35	
1	75	75	80	80	80	80	80	80	0.00
2	75	75	80	80	80	80	80	80	0.00
3	75	75	80	80	80	80	80	80	0.00
4	75	75	80	80	80	80	80	80	0.00
5	75	75	80	80	80	80	80	80	0.00
6	80	80	80	80	80	80	80	80	0.00
7	80	80	80	80	80	80	80	80	0.00
8	90	85	90	80	85	80	80	80	0.02
9	115	105	100	90	95	90	85	85	0.03
10	130	125	120	105	115	105	100	100	0.04
11	155	150	145	120	135	125	115	105	0.07
12	180	175	165	140	155	140	130	125	0.07
13	195	190	165	145	150	140	135	130	0.08
14	225	215	170	160	150	150	145	145	0.04
15	240	235	180	165	155	175	155	180	0.04
16	255	255	185	170	170	200	175	210	0.00
17	265	265	200	185	180	200	180	220	0.00
18	300	285	230	210	190	200	190	220	0.00
19	310	295	240	220	195	210	200	225	-0.01
20	305	295	245	220	200	210	200	230	-0.01

## Test E-2

**Date:** April 19, 1959

**Outdoor Temperature:** 67° F. **Humidity:** 65% **Wind:** 5 8  
m p h. W Average

**Fuel:** 1,400 pounds of pallets

**Location of Test Fire:** Base of stairway No 2

**Automatic Sprinklers:** None

**Vents:** 21 square feet at top of stairway No 2; 21 square feet at  
top of stairway No. 1

**Curtain Boards:** Corridors and stairway openings to corridors

**Automatic Fire Detection:** Coverage as shown in Figure 12

**Other:** Vents operated by fusible links rated at 165 degrees  
Fahrenheit.

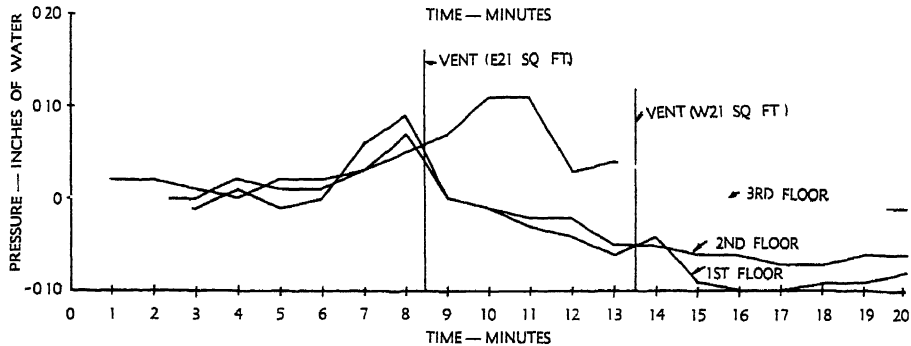
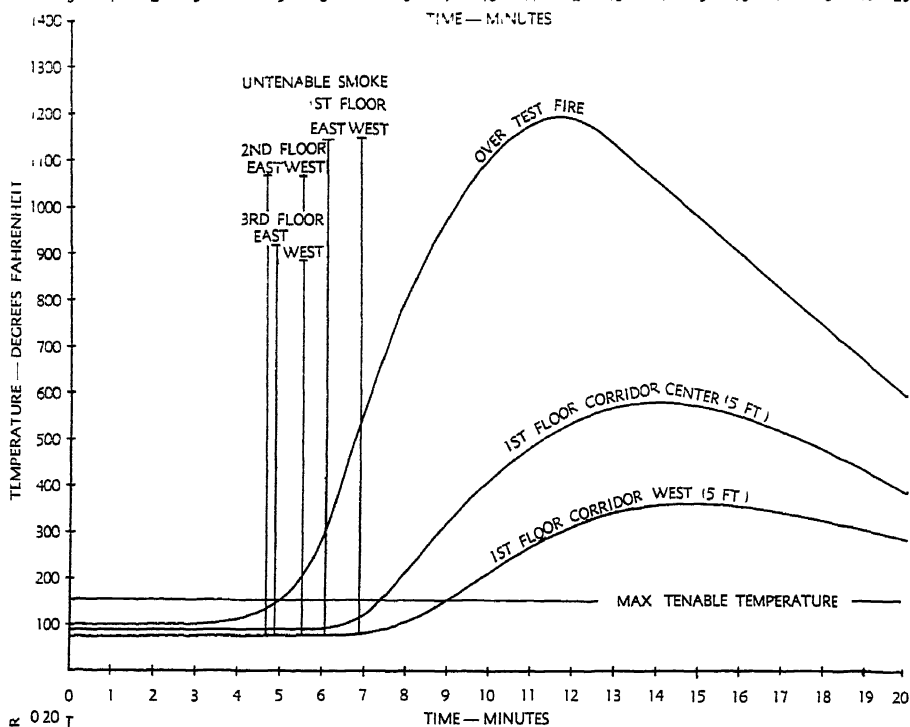
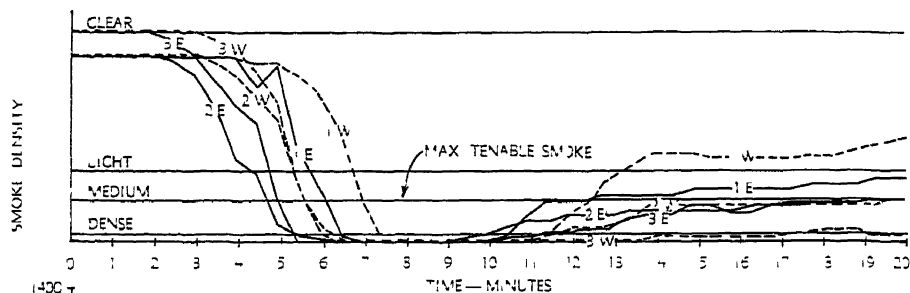
### Comments:

Test fire was relatively slow developing.

Vents operated (8½ minutes over stairway No. 2; 13½ minutes over stairway No 1) after all corridors became untenable from smoke. Partial clearing took place about 3 minutes after first vent opened but this may have been due to more complete combustion at the test fire which resulted in clearing in most every test.

Curtain boards did not measurably delay smoke spread.

Delay in smoke untenability in first floor corridor unexplained



## Automatic Fire Detection System

Circuit No.	Area Covered	Response Time from Fire Start	
		Minutes	Seconds
1	1st Floor Corridor	7	25
2	2nd Floor Corridor	9	25
3	3rd Floor Corridor	10	43
4	Room 203	10	25
5	Stairway No 2	4	25
6	Stairway No. 1	9	30

## Temperature and Pressure Readings

FIRST FLOOR								
Time Min- utes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11	12U	12L	13U	13L	14U	14L	
1	100	85	80	90	90	90	75	0.02
2	100	85	80	90	90	90	75	0.02
3	100	85	80	90	90	90	75	0.01
4	115	85	80	90	90	90	80	0.00
5	130	90	85	90	90	90	80	0.02
6	290	100	85	100	90	90	80	0.02
7	555	150	115	125	115	90	80	0.03
8	1060	345	350	160	200	90	85	0.07
9	1055	795	550	290	270	135	145	0.00
10	1080	555	685	415	420	230	215	-0.01
11	1180	625	710	485	495	295	280	-0.03
12	1200	645	780	525	540	330	305	-0.04
13	1120	640	740	540	560	355	365	-0.06
14	1005	610	695	555	585	380	350	-0.04
15	965	595	690	550	560	390	360	-0.09
16	885	570	635	530	540	385	360	-0.10
17	835	515	595	490	500	370	345	-0.10
18	760	475	525	450	460	350	325	-0.09
19	660	435	475	415	420	320	300	-0.09
20	600	410	435	380	390	300	290	-0.08

## Temperature and Pressure Readings

SECOND FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	21	22U	22L	23U	23L	24U	24L	25	
1	90	80	80	90	90	85	85	85	0.00
2	90	80	80	90	90	85	85	85	0.00
3	90	85	80	90	90	85	85	85	-0.01
4	90	85	80	90	90	85	85	85	0.01
5	100	90	85	90	90	85	85	85	-0.01
6	135	100	90	100	100	95	85	85	0.00
7	210	145	105	110	110	105	90	100	0.06
8	410	285	180	155	135	135	105	135	0.09
9	550	415	285	240	225	210	140	170	0.00
10	640	465	325	320	295	275	175	200	-0.01
11	685	525	355	385	350	315	205	220	-0.02
12	720	545	390	405	375	335	230	230	-0.02
13	720	565	405	425	390	355	235	255	-0.02
14	700	555	400	430	400	360	250	275	-0.05
15	650	510	375	425	390	355	255	270	-0.06
16	610	485	360	405	375	345	255	260	-0.06
17	555	460	355	390	365	330	250	250	-0.07
18	520	445	350	375	345	320	250	235	-0.07
19	485	400	335	355	330	310	240	222	-0.06
20	440	370	315	330	310	290	240	220	-0.06

THIRD FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	31	32U	32L	33U	33L	34U	34L	35	
1	85	80	85	80	85	80	80	95	0.00
2	85	80	85	80	85	80	80	95	0.00
3	85	80	85	80	85	80	80	85	0.00
4	85	80	85	80	85	80	80	85	0.02
5	90	85	85	80	85	80	80	85	0.01
6	100	90	100	85	90	85	85	90	0.01
7	150	110	125	100	110	100	95	90	0.03
8	255	180	170	120	140	125	110	105	0.05
9	325	220	285	155	145	150	135	120	0.07
10	370	255	205	190	160	165	150	150	0.11
11	415	295	230	205	165	185	170	165	0.11
12	435	305	235	225	175	200	180	180	0.03
13	430	305	250	235	190	205	190	200	0.04
14	425	315	260	245	200	215	200	220	0.03
15	405	315	275	250	205	220	210	220	0.02
16	395	315	270	250	210	225	210	225	-0.01
17	380	305	265	240	210	220	210	220	-0.01
18	365	305	255	240	215	220	210	215	-0.01
19	350	295	250	240	215	220	215	215	-0.01
20	330	280	235	230	215	215	210	205	-0.01

### Test E-3

**Date:** April 19, 1959

**Outdoor Temperature:** 67° F   **Humidity:** 65%   **Wind:** 5 8  
m p.h. W Average

**Fuel:** 1,400 pounds of pallets

**Location of Test Fire:** First floor corridor slightly east of corridor curtain board

**Automatic Sprinklers:** None

**Vents:** 21 square feet at top of stairway No. 2; 21 square feet at top of stairway No. 1

**Curtain Boards:** Corridors and stairway openings to corridors

**Automatic Fire Detection:** Coverage as shown in Figure 12

**Other:** Vents operated by fusible links rated at 165 degrees Fahrenheit.

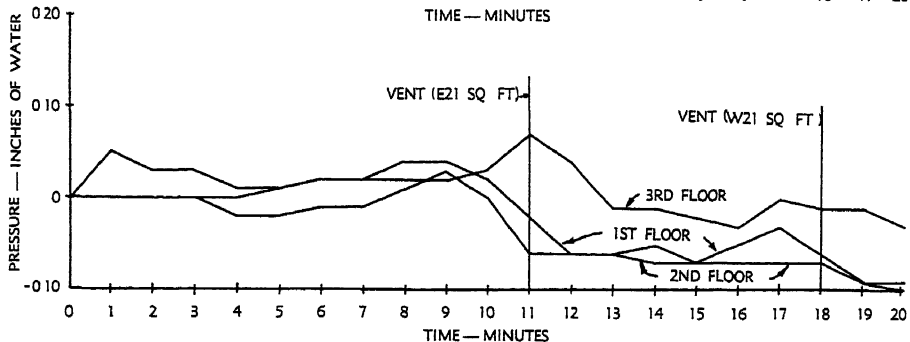
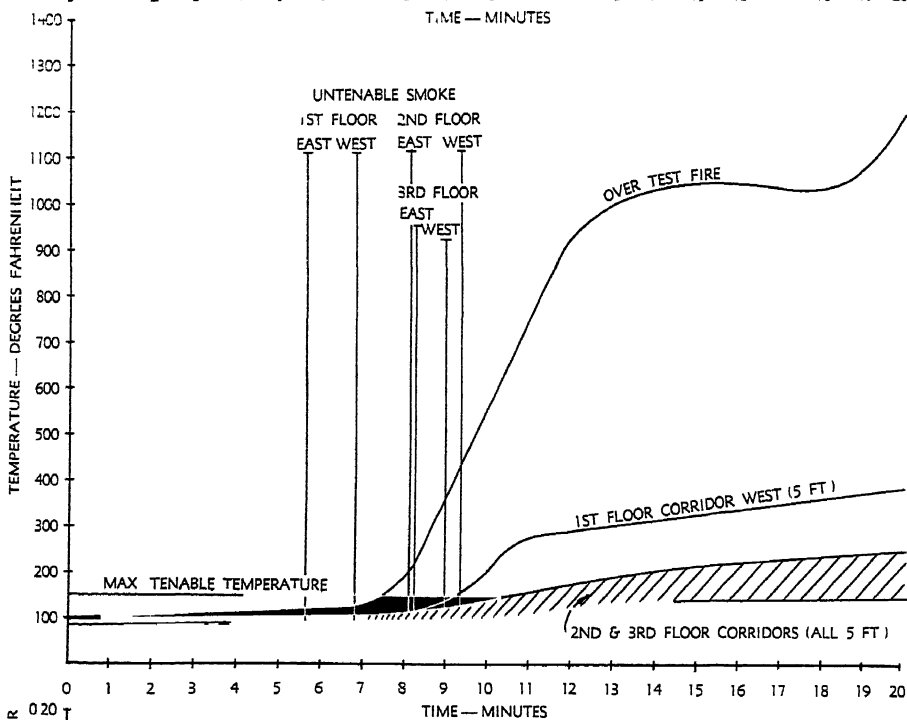
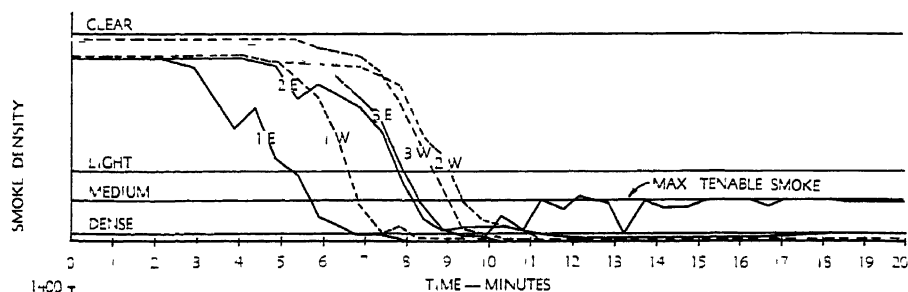
**Comments:**

Test fire was very slow developing.

Curtain boards did not measurably retard smoke spread through corridors.

Vents (opened 11 minutes over stairway No. 2; 18 minutes over stairway No. 1) failed to clear smoke from corridors.

Location of test fire had no effect on the time at which smoke conditions became untenable in corridors.



## Automatic Fire Detection System

Circuit No.	Area Covered	Response Time from Fire Start	
		Minutes	Seconds
1	1st Floor Corridor	6	5
2	2nd Floor Corridor	8	55
3	3rd Floor Corridor	9	25
4	Room 203	8	40
5	Stairway No. 2	7	15
6	Stairway No. 1	9	20

## Temperature and Pressure Readings

FIRST FLOOR								
Time Min- utes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11	12U	12L	13U	13L	14U	14L	
1	120	105	95	100	100	100	90	0.05
2	135	105	95	100	100	100	90	0.03
3	135	105	95	110	100	100	90	0.03
4	140	105	95	115	100	100	90	0.01
5	140	105	95	120	100	100	90	0.01
6	140	120	105	125	100	100	90	0.02
7	145	150	120	130	110	100	95	0.02
8	145	250	160	105	130	115	100	0.04
9	145	460	300	340	200	175	135	0.04
10	150	665	455	530	380	220	205	0.02
11	150	920	605	730	570	310	310	-0.02
12	150	990	710	1000	600	390	285	-0.06
13	140	975	725	990	560	420	290	-0.06
14	140	1045	775	995	600	390	265	-0.05
15	135	995	790	1030	880	430	310	-0.07
16	130	995	805	1050	880	450	310	-0.05
17	130	1015	800	1030	860	470	345	-0.07
18	135	1040	820	1040	900	500	350	-0.06
19	125	1055	840	1080	940	510	375	-0.09
20	125	1080	880	1200	970	540	400	-0.09

## Temperature and Pressure Readings

SECOND FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	21	22U	22L	23U	23L	24U	24L	25	
1	110	100	95	105	100	100	90	90	0.00
2	110	100	95	105	100	100	90	90	0.00
3	110	100	95	105	100	100	95	95	0.00
4	110	100	95	100	100	100	90	90	-0.02
5	110	100	95	110	105	105	100	100	-0.02
6	115	100	100	105	105	105	100	100	-0.01
7	115	105	100	110	110	110	100	100	-0.01
8	130	110	105	110	110	110	100	100	0.01
9	195	130	110	115	115	110	100	100	0.03
10	245	160	135	130	120	120	100	110	0.00
11	325	185	165	150	140	135	110	160	-0.06
12	375	195	160	170	150	140	125	220	-0.06
13	425	220	180	185	160	155	135	230	-0.06
14	455	220	195	190	170	165	140	240	-0.07
15	460	265	215	215	185	130	150	260	-0.07
16	470	275	230	230	200	190	160	270	-0.07
17	470	290	230	240	210	200	170	280	-0.07
18	475	295	240	250	220	210	170	290	-0.07
19	485	300	250	255	230	215	175	300	-0.09
20	495	305	250	260	230	220	180	320	-0.10

THIRD FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	31	32U	32L	33U	33L	34U	34L	35	
1	110	100	90	80	80	80	80	80	0.00
2	110	100	90	80	80	80	80	80	0.00
3	110	100	100	95	95	95	95	90	0.00
4	110	100	100	95	100	95	95	90	0.00
5	110	100	105	100	100	100	100	95	0.01
6	105	100	105	100	100	100	100	95	0.02
7	110	100	110	100	100	100	100	95	0.02
8	115	105	110	100	105	100	100	100	0.02
9	140	115	120	100	110	100	100	100	0.02
10	175	165	140	120	130	115	110	105	0.03
11	205	140	160	140	150	135	125	120	0.07
12	220	175	160	150	150	145	140	140	0.04
13	225	175	160	150	140	140	135	155	-0.01
14	240	180	160	150	140	145	140	160	-0.01
15	250	185	160	155	145	150	140	180	-0.02
16	255	190	155	150	140	160	140	190	-0.03
17	260	195	155	150	150	165	140	200	0.00
18	265	195	160	150	150	170	145	200	-0.01
19	275	205	165	160	150	165	150	200	-0.01
20	285	220	180	160	155	170	155	200	0.02

### Test E-4

**Date:** April 21, 1959

**Outdoor Temperature:** 69° F   **Humidity:** 70%   **Wind:** 5.8  
m.p.h. W Average

**Fuel:** 1,400 pounds of pallets

**Location of Test Fire:** Base of stairway No 2

**Automatic Sprinklers:** None

**Vents:** 42 square feet at top of stairway No 2

**Curtain Boards:** Corridors and stairway openings to corridors.

**Automatic Fire Detection:** Coverage as shown in Figure 12

**Other:** Vent arbitrarily opened 5 minutes after test fire ignited.

**Comments:**

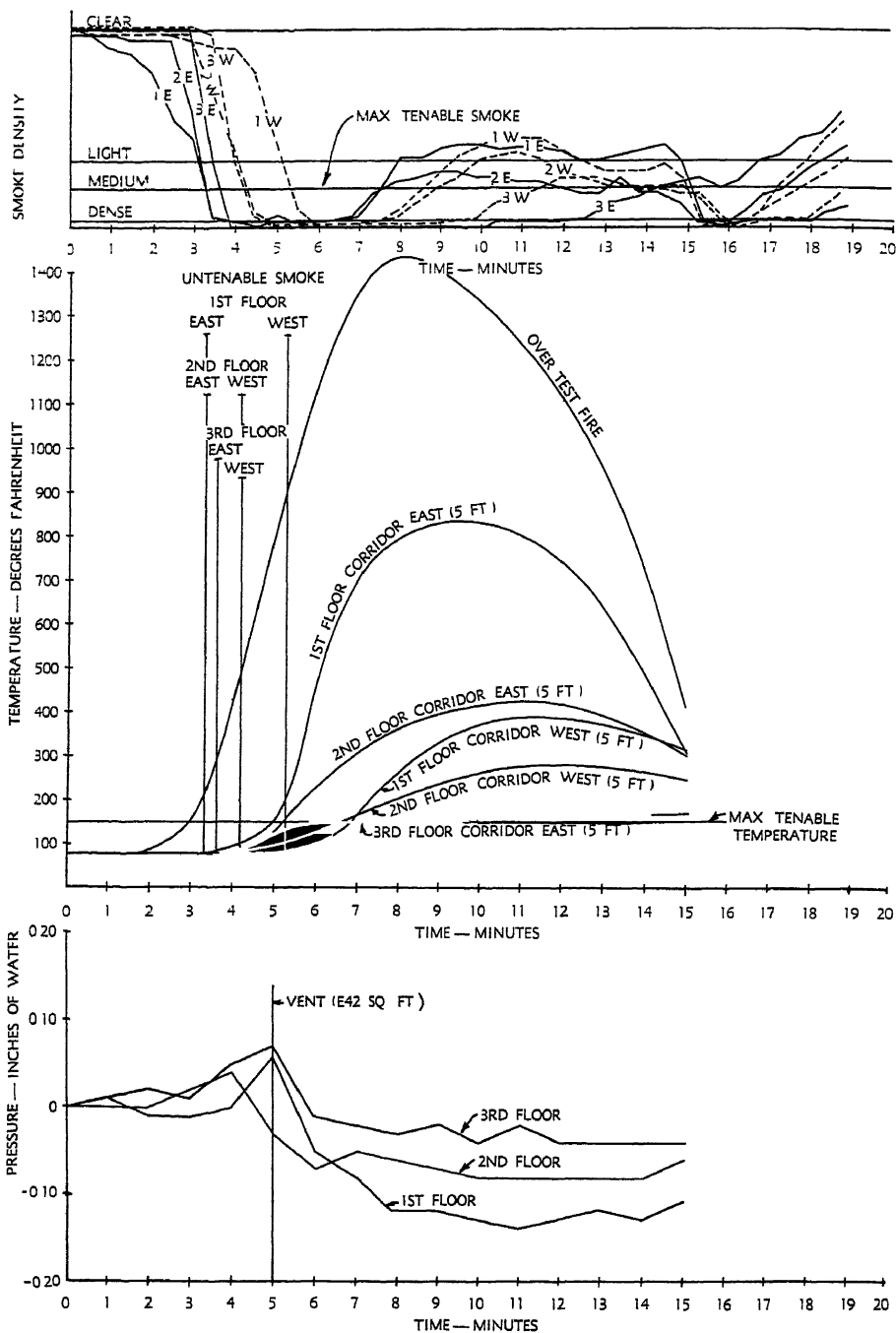
Relatively fast developing test fire

Curtain boards did not delay spread of smoke except in first floor corridor

Curtain boards banked heat so that higher temperatures were recorded at thermocouples at the 5 foot level than those 8 inches from the ceiling in locations closest to the test fire. On upper floors temperature difference between upper and lower thermocouples at the same location were less than in tests with no curtain boards.

After vent opened, smoke started to clear in first and second floor corridors in 2 minutes. Third floor corridor started to clear in 5 minutes at the west end and 7 minutes at east end after the vent was opened.

Temperatures in the corridors were still at untenable levels when clearing took place.



## Automatic Fire Detection System

Circuit No.	Area Covered	Response Time from Fire Start	
		Minutes	Seconds
1	1st Floor Corridor	3	47
2	2nd Floor Corridor	4	2
3	3rd Floor Corridor	4	32
4	Room 203	4	22
5	Stairway No 2	2	52
6	Stairway No 1	4	17

## Temperature and Pressure Readings

FIRST FLOOR								
Time Min- utes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11	12U	12L	13U	13L	14U	14L	
1	75	75	75	75	75	75	75	0.01
2	75	75	75	75	75	75	75	-0.01
3	150	75	75	75	75	75	75	-0.01
4	425	120	105	75	75	75	75	0.00
5	725	170	140	125	110	75	75	0.01
6	1225	425	470	250	220	110	95	-0.05
7	1290	550	705	375	360	190	175	-0.08
8	1450	650	840	520	540	310	250	-0.12
9	1350	675	825	580	600	400	350	-0.12
10	1300	660	780	580	600	410	375	-0.13
11	1300	675	810	590	610	420	380	-0.14
12	1110	640	740	575	590	415	390	-0.13
13	780	575	625	500	510	390	375	-0.12
14	780	485	530	465	485	370	350	-0.13
15	415	345	310	380	380	335	315	-0.11
16								
17								
18								
19								
20								



### Test E-5

**Date:** April 21, 1959

**Outdoor Temperature:** 67° F   **Humidity:** 70%   **Wind:** 5 8  
m p h   **W Average**

**Fuel:** 1,400 pounds of pallets

**Location of Test Fire:** Base of stairway No 2

**Automatic Sprinklers:** None

**Vents:** 42 square feet at top of stairway No 2

**Curtain Boards:** Corridors and in stairway openings to corridors

**Automatic Fire Detection:** Coverage as shown in Figure 12

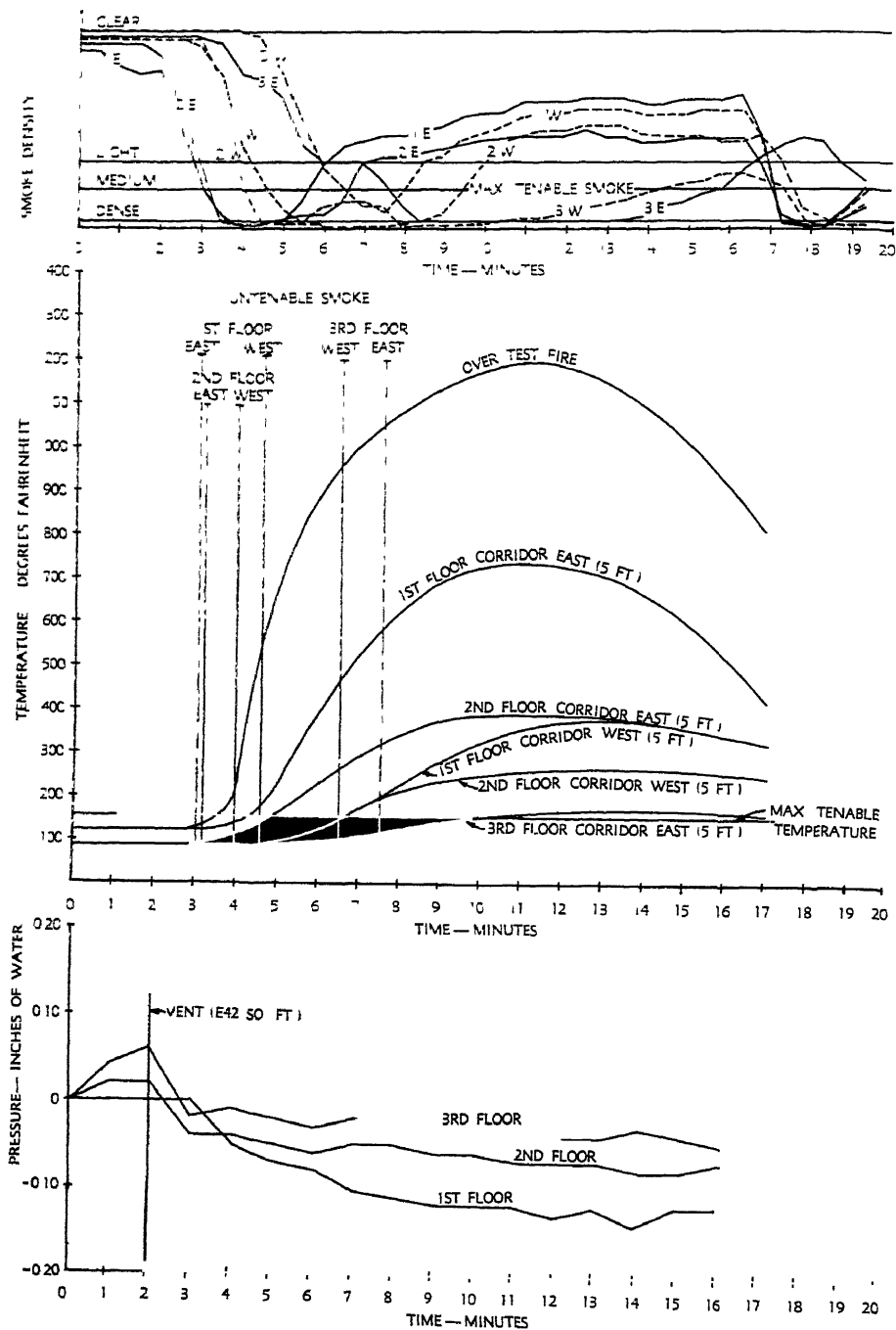
**Other:** Vent opened arbitrarily 2 minutes after start of test fire

**Comments:**

Clearing of smoke in the first floor corridor east and west end started after 5 and 5½ minutes respectively; in the second floor east and west in 6 and 8½ respectively and in the third floor west and east in 10½ and 13½ respectively. Again this was probably due more to complete combustion than to the action of the vent

Opening the vent 3 minutes sooner than in the foregoing test did not indicate any appreciable change in results.

Curtain boards did not delay spread of smoke, and temperature conditions as a result of the boards were similar to those encountered in the foregoing test



## Automatic Fire Detection System

Circuit No.	Area Covered	Response Time from Fire Start	
		Minutes	Seconds
1	1st Floor Corridor	4	40
2	2nd Floor Corridor	5	10
3	3rd Floor Corridor	6	50
4	Room 203	5	40
5	Stairway No. 2	4	5
6	Stairway No. 1	5	15

## Temperature and Pressure Readings

FIRST FLOOR								
Time Min- utes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11	12U	12L	13U	13L	14U	14L	
1	110	90	90	80	80	80	90	0.00
2	120	90	90	80	80	80	90	0.00
3	125	95	95	80	80	80	75	0.00
4	250	125	130	105	100	100	75	-0.05
5	510	215	235	140	140	100	90	-0.07
6	965	350	405	250	240	140	115	-0.08
7	1010	460	540	350	350	210	165	-0.10
8	1050	530	615	450	450	290	240	-0.11
9	1100	570	700	500	515	340	285	-0.12
10	1150	615	710	540	550	375	330	-0.12
11	1200	625	715	560	575	400	355	-0.12
12	1200	620	745	550	565	400	370	-0.13
13	1150	590	670	550	565	400	375	-0.12
14	1080	565	645	530	550	400	380	-0.14
15	1050	540	630	505	520	385	370	-0.12
16	825	495	545	450	465	360	335	-0.12
17		435	425				320	-0.08
18								
19								
20								

### Temperature and Pressure Readings

[illegible][illegible]

### Test E-6

**Date:** April 22, 1959

**Outdoor Temperature:** 73° F   **Humidity:** 62%   **Wind:** 4.7  
m p h. W Average

**Fuel:** 1,400 pounds of solid pallets

**Location of Test Fire:** Base of stairway No 2

**Automatic Sprinklers:** None

**Vents:** 63 square feet at top of stairway No 2

**Curtain Boards:** Corridors and stairway openings to corridors

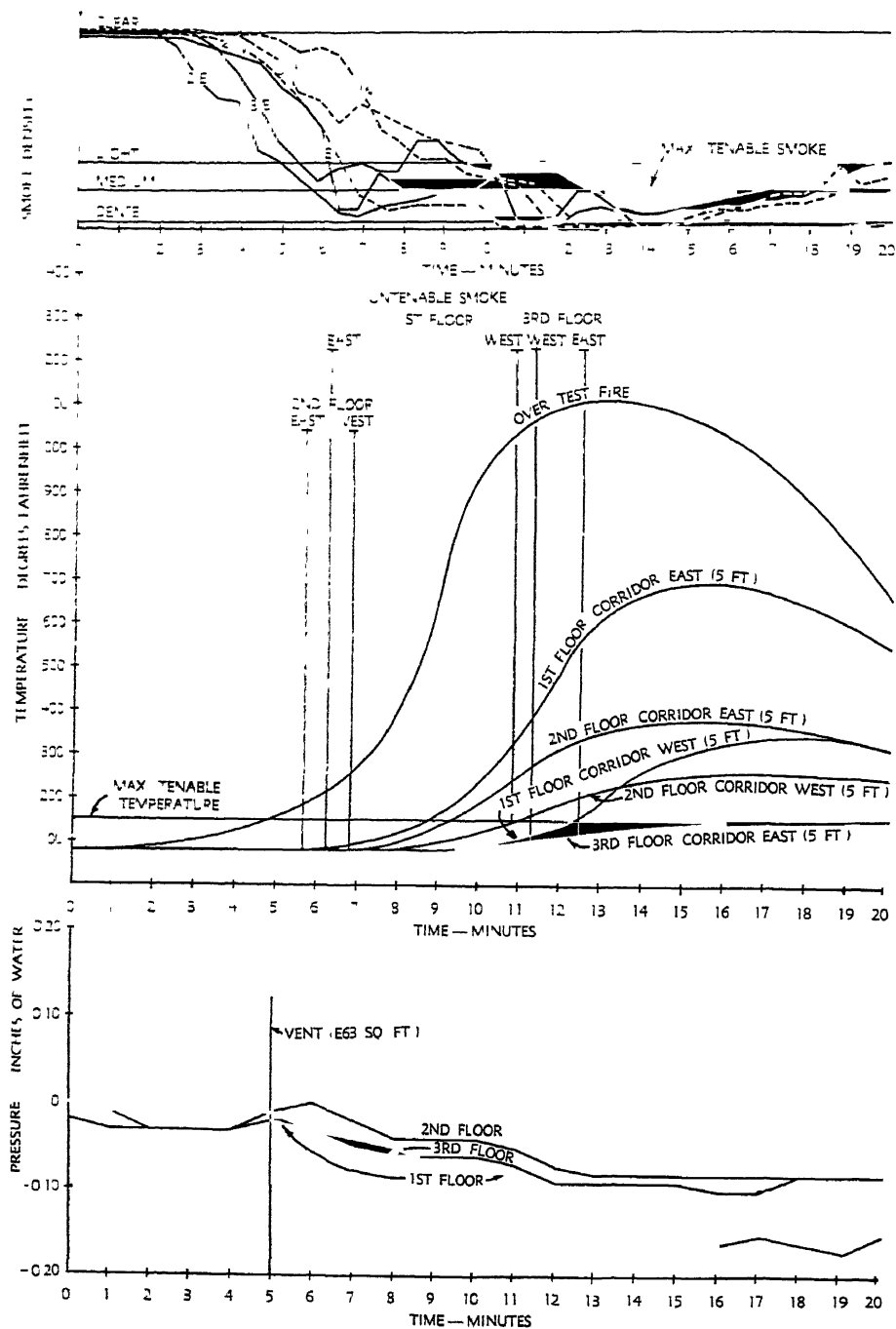
**Automatic Fire Detection:** Coverage as indicated in Figure 12

**Other:** Vent opened when temperature at thermocouple nearest  
test fire reached 150 degrees Fahrenheit.

**Comments:**

Test fire very slow developing

The vent-curtain-board combination did delay untenable smoke conditions at the west end of the first floor corridor and third floor corridor



## Automatic Fire Detection System

Circuit No.	Area Covered	Response Time from Fire Start	
		Minutes	Seconds
1	1st Floor Corridor	6	0
2	2nd Floor Corridor	7	0
3	3rd Floor Corridor	10	50
4	Room 203	11	5
5	Stairway No. 2	3	55
6	Stairway No. 1	8	10

## Temperature and Pressure Readings

FIRST FLOOR								
Time Min- utes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11	12U	12L	13U	13L	14U	14L	
1	90	90	90	90	90	90	90	-0.01
2	95	90	90	90	90	90	90	-0.03
3	120	90	90	90	90	90	90	-0.03
4	125	90	90	90	90	90	90	-0.03
5	155	90	90	90	90	90	90	-0.02
6	225	90	90	90	90	90	90	-0.03
7	230	112	95	95	95	90	90	-0.04
8	395	135	100	105	95	90	90	-0.05
9	660	180	155	125	105	95	90	-0.07
10	1045	230	230	175	115	105	90	-0.07
11	1095	465	400	290	175	130	105	-0.08
12	1085	480	430	370	255	185	90	-0.11
13	1045	560	570	405	335	215	195	-0.12
14	1090	575	710	475	460	290	270	-0.14
15	1030	595	670	510	505	340	300	-0.16
16	1065	585	685	520	520	360	320	-0.16
17	980	580	670	530	535	375	340	-0.15
18	870	550	600	515	525	380	350	-0.16
19	830	525	585	485	490	365	345	-0.17
20	655	480	525	460	465	350	330	-0.15

## Temperature and Pressure Readings

SECOND FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	21	22U	22L	23U	23L	24U	24L	25	
1	90	90	90	90	90	90	90	90	-0.01
2	90	90	90	90	90	90	90	90	-0.01
3	90	90	90	90	90	90	90	90	-0.01
4	90	90	90	90	90	90	90	90	-0.01
5	95	90	90	90	90	90	90	90	-0.01
6	95	90	90	90	90	90	90	90	0.00
7	100	100	90	90	90	90	90	90	-0.02
8	120	125	105	105	105	90	90	90	-0.04
9	147	145	125	120	115	100	100	95	-0.04
10	210	260	175	175	160	110	120	105	-0.04
11	350	375	260	245	235	150	155	120	-0.05
12	505	435	320	305	295	215	190	145	-0.07
13	540	460	325	340	325	275	210	165	-0.08
14	580	500	380	375	355	290	245	215	-0.08
15	615	500	380	365	365	320	250	250	-0.08
16	620	465	370	390	370	325	265	265	-0.08
17	610	460	360	390	365	330	265	275	-0.08
18	595	460	350	380	360	325	265	285	-0.08
19	575	440	340	365	350	325	260	270	-0.08
20	535	415	325	350	335	315	255	265	-0.08

THIRD FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	31	32U	32L	33U	33L	34U	34L	35	
1	90	90	90	90	90	90	90	90	-0.03
2	90	90	90	90	90	90	90	90	-0.03
3	90	90	90	90	90	90	90	90	-0.03
4	90	90	90	90	90	90	90	90	-0.03
5	90	90	90	90	90	90	90	90	-0.01
6	90	90	90	90	90	90	90	90	-0.03
7	97	90	90	90	90	90	90	90	-0.05
8	112	90	90	90	90	90	90	90	-0.06
9	140	90	90	90	90	90	90	90	-0.06
10	215	95	95	95	90	90	90	100	-0.06
11	275	130	100	105	95	110	95	130	-0.07
12	270	140	115	115	110	145	115	175	-0.09
13	280	145	125	130	120	155	130	195	-0.09
14	305	145	135	155	145	170	155	215	-0.09
15	310	150	140	170	160	175	160	220	-0.09
16	305	155	145	180	170	180	170	230	-0.10
17	300	160	150	180	175	185	175	235	-0.10
18	265	160	155	185	175	190	180	240	-0.08
19	275	165	160	185	180	190	180	235	-0.08

### Test E-7

**Date:** May 21, 1959

**Outdoor Temperature:** 69° F   **Humidity:** 64%   **Wind:** 6.5 m.p.h. S Average

**Fuel:** 1,400 pounds of pallets

**Location of Test Fire:** Base of stairway No. 2

**Automatic Sprinklers:** None

**Vents:** 42 square feet at top of stairway No. 2

**Curtain Boards:** Corridors and stairway openings to corridors

**Automatic Fire Detection:** None

**Other:** Vent opened when temperature at thermocouple nearest test fire reached 150 degrees Fahrenheit. Center of both stairways opened to provide unobstructed passage to the top. A 165 degree Fahrenheit fusible link suspended in opening of stairway No. 2 at the first floor level.

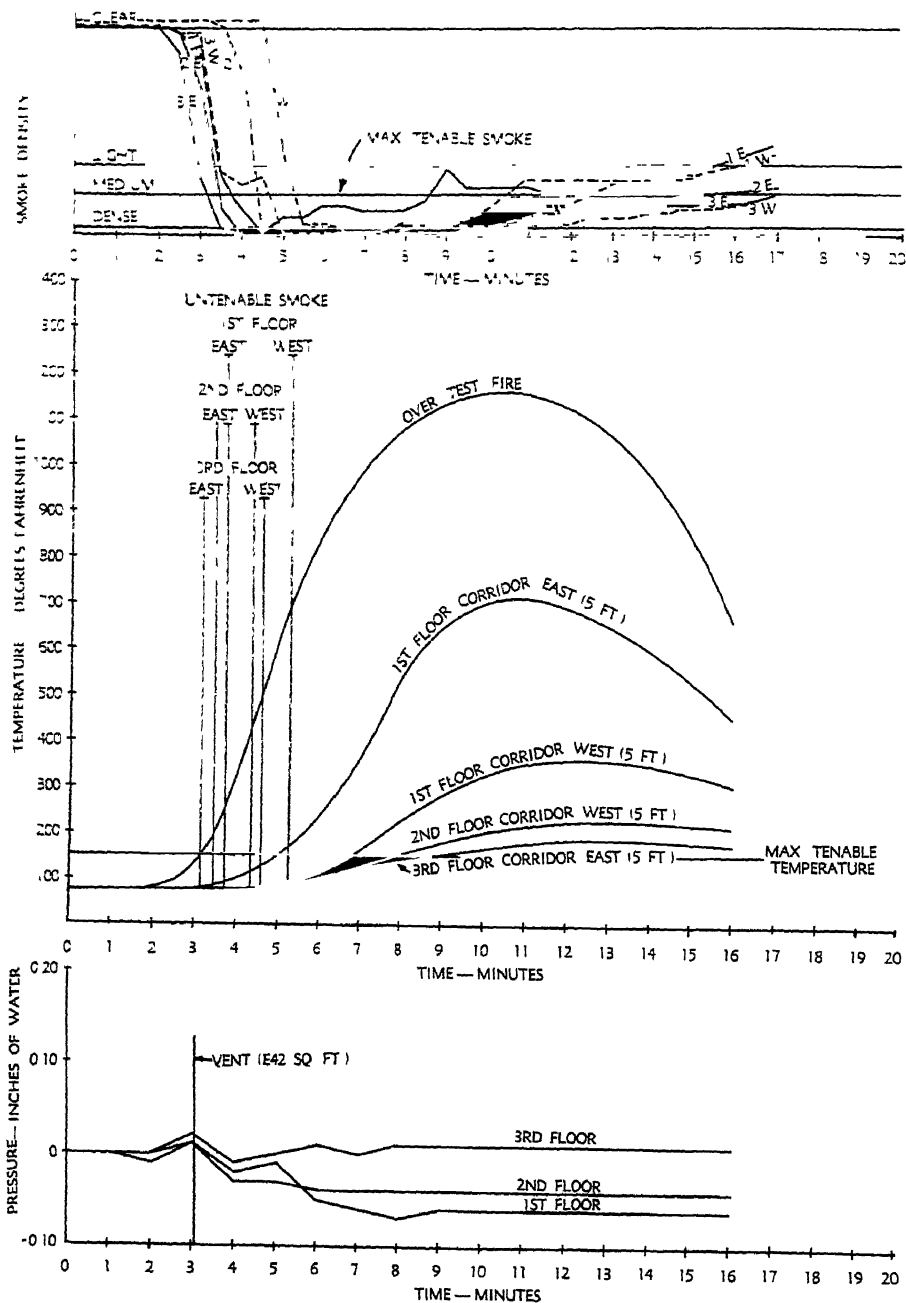
#### Comments:

Test fire developed relatively fast.

Smoke continued to intensify on all floors after vent was opened but started to clear in the first floor corridor 4½ minutes after fire started at the east end and 7½ minutes in the east end of the second floor corridor.

Vent action was not satisfactory for tenable conditions.

Fusible link in stairway opening operated in 4½ minutes.



## Temperature and Pressure Readings

FIRST FLOOR								
Time Minutes	Temperature-Degrees Fahrenheit						Pressure Inches of Water	
	Thermocouple Location							
	11	12U	12L	13U	13L	14U		14L
1	80	75	75	80	80	80	78	0.00
2	90	75	75	80	80	80	78	0.00
3	100	80	75	80	80	80	78	0.01
4	370	105	80	80	80	80	75	-0.02
5	690	195	130	120	130	135	120	-0.01
6	820	355	235	190	220	115	100	-0.05
7	975	465	365	295	340	205	155	-0.06
8	1075	520	500	380	445	260	210	-0.07
9	1140	555	710	450	510	320	255	-0.06
10	1130	565	730	480	540	345	305	-0.06
11	1155	605	720	510	565	370	360	-0.06
12	1190	595	685	535	590	415	370	-0.06
13	1040	580	605	525	560	415	355	-0.06
14	870	515	525	480	530	405	355	-0.06
15	760	500	540	450	490	375	340	-0.06
16	670	445	470	420	450	350	310	-0.06
17								
18								
19								
20								

[illegible]



**Test E-8**

**Date:** May 9, 1959

**Outdoor Temperature:** 71° F. **Humidity:** 49% **Wind:** 6.2  
m.p.h. SW Average

**Fuel:** 1,400 pounds of pallets

**Location of Test Fire:** Base of stairway No 2

**Automatic Sprinklers:** None

**Vents:** 42 square feet at top of stairway No 2

**Curtain Boards:** Corridors only

**Automatic Fire Detection:** None

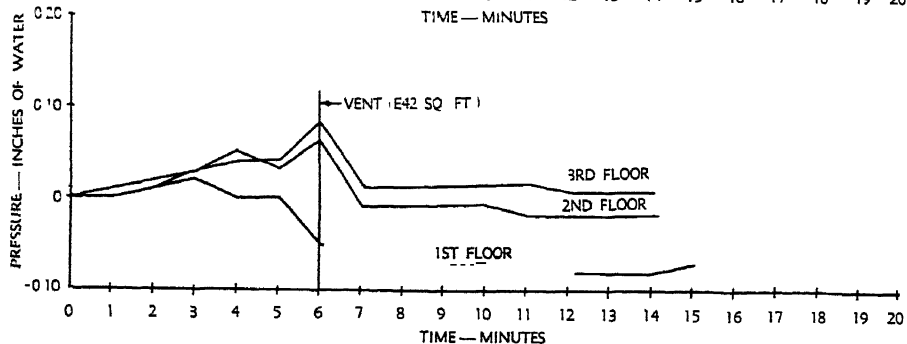
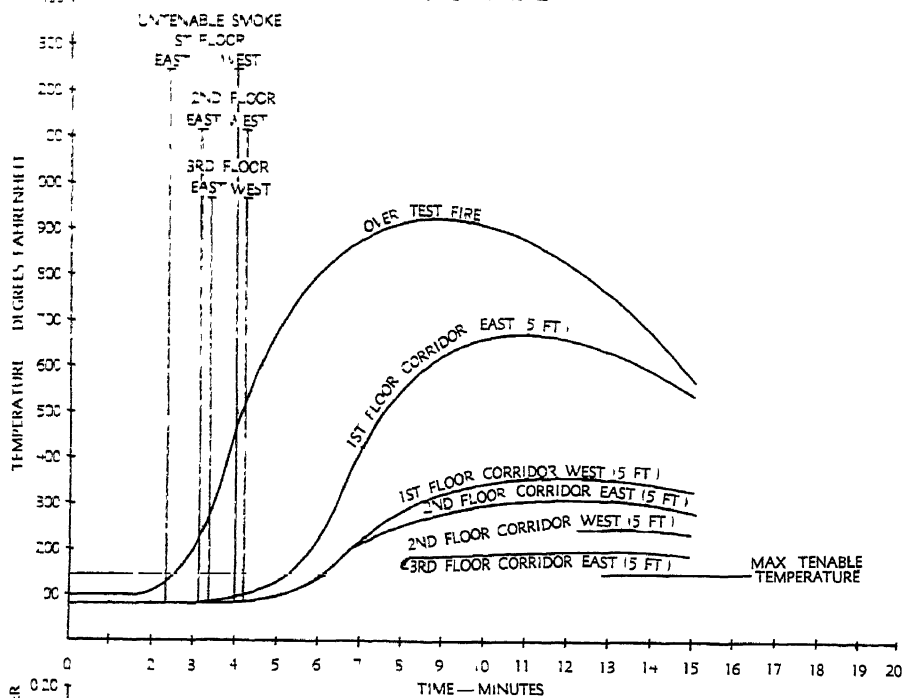
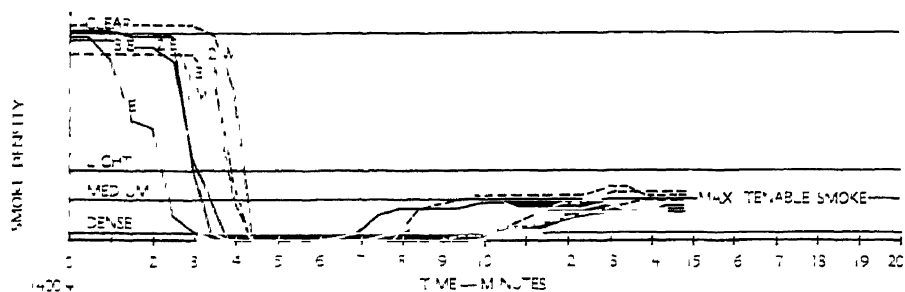
**Other:** Vent opened by operation of fusible link rated at 165  
degrees Fahrenheit. Open shaft 4 feet in diameter in stair-  
way No. 2.

**Comments:**

Untenable smoke conditions were reached in all cor-  
ridors about 4 minutes after start of test fire

Corridors started to clear 6 minutes after start of test  
fire either because of vent action or more complete com-  
bustion

Vent opened in 6 minutes.



## Temperature and Pressure Readings

FIRST FLOOR								
Time Min- utes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11	12U	12L	13U	13L	14U	14L	
1	95	75	65	90	90	90	80	0.00
2	100	75	65	90	90	90	80	0.01
3	135	90	90	90	90	90	85	0.02
4	500	120	95	120	130	90	85	0.00
5	825	350	120	205	240	120	95	0.00
6	825	540	230	305	360	185	145	-0.05
7	050	615	415	405	445	285	245	-0.06
8	845	680	585	425	530	350	235	-0.07
9	920	685	630	515	545	320	340	-0.07
10	805	675	600	525	555	320	320	-0.07
11	945	695	670	540	585	400	355	-0.07
12	850	660	640	540	575	400	345	-0.08
13	740	605	590	515	540	390	340	-0.08
14	640	575	585	490	520	380	340	-0.08
15		550	535				330	-0.07
16								
17								
18								
19								
20								

[illegible]



**Test E-9**

**Date:** April 24, 1959

**Outdoor Temperature:** 66° F   **Humidity:** 54%   **Wind:** 6.5  
m p.h W Average

**Fuel:** 1,400 pounds of pallets

**Location of Test Fire:** Base of stairway No. 2

**Automatic Sprinklers:** None

**Vents:** 31.5 square feet at top of stairway No. 2

**Curtain Boards:** Corridors and stairwell openings to corridors

**Automatic Fire Detection:** Coverage as shown in Figure 12

**Other:** Vent opened by operation of fusible link rated at 165 degrees Fahrenheit Two doors hung with spring loaded hinges installed in partition at curtain board in all corridors; one door opening in each direction. Automatic door closers installed on two classroom doors opening into the second floor corridor east of curtain board.

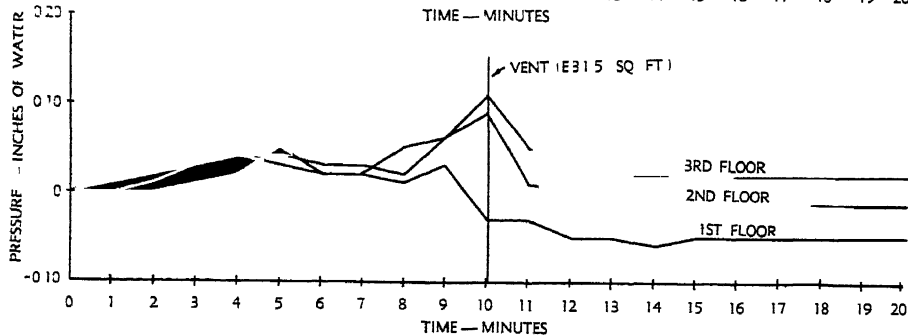
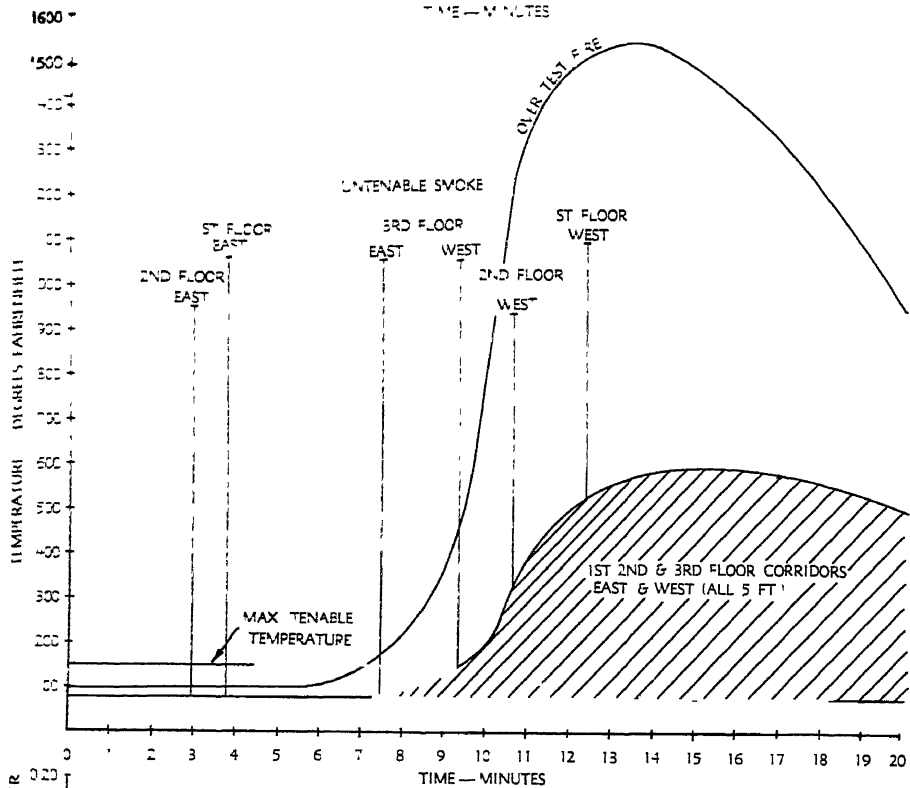
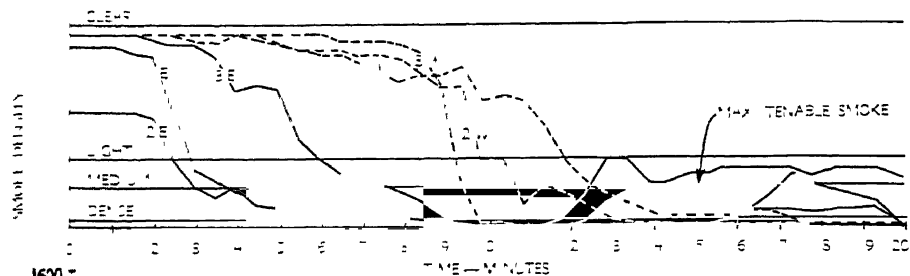
**Comments:**

Test fire very slow developing.

Doors pushed open by fire gas pressure allowing smoke to enter west end of each corridor so that they all became untenable from smoke eventually.

Automatic door closers operated 12 minutes after start of test fire.

Vent opened in 10 minutes



## Automatic Fire Detection System

Circuit No.	Area Covered	Response Time from Fire Start	
		Minutes	Seconds
1	1st Floor Corridor	7	50
2	2nd Floor Corridor	8	20
3	3rd Floor Corridor	9	1
4	Room 203	8	40
5	Stairway No. 2	7	25
6	Stairway No. 1	8	41

## Temperature and Pressure Readings

FIRST FLOOR								
Time Min- utes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11	12U	12L	13U	13L	14U	14L	
1	85	75	75	85	85	85	75	0.00
2	95	80	75	85	85	85	75	0.00
3	100	85	75	85	85	85	75	0.01
4	100	85	80	85	85	85	75	0.02
5	90	85	80	85	85	85	75	0.05
6	90	85	80	85	85	85	75	0.02
7	90	85	80	85	85	85	75	0.02
8	100	85	85	85	85	85	75	0.01
9	285	120	85	100	95	85	75	0.03
10	765	205	185	160	150	85	75	-0.03
11	1360	395	350	290	255	85	75	-0.03
12	1490	540	545	425	355	85	75	-0.05
13	1535	505	560	460	390	85	75	-0.05
14	1485	645	570	505	450	90	80	-0.06
15	1235	610	540	500	440	95	80	-0.05
16	1380	660	580	520	465	105	85	-0.05
17	1355	655	545	530	465	110	85	-0.05
18	1205	625	520	495	430	110	85	-0.05
19	1070	530	445	460	390	110	85	-0.05
20	950	480	420	420	365	105	85	-0.05

## Temperature and Pressure Readings

SECOND FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	21	22U	22L	23U	23L	24U	24L	25	
1	80	80	75	85	85	85	85	85	0.00
2	80	80	80	85	85	85	85	85	0.01
3	85	80	80	85	85	85	85	85	0.03
4	85	85	80	85	85	85	85	85	0.04
5	85	85	80	85	85	85	85	85	0.03
6	85	85	80	85	85	85	85	85	0.02
7	85	85	80	85	85	85	85	85	0.02
8	85	85	80	85	85	85	85	85	0.05
9	135	90	80	85	85	85	85	85	0.06
10	255	145	100	120	110	85	85	85	0.09
11	475	315	195	215	200	95	85	85	0.01
12	625	480	405	375	340	100	85	85	0.00
13	670	535	490	415	385	100	85	85	-0.01
14	745	585	540	475	440	105	85	85	-0.01
15	730	590	550	495	460	115	90	90	-0.01
16	745	595	575	515	475	120	90	90	-0.01
17	730	600	565	520	490	125	95	95	-0.01
18	690	575	570	505	460	125	100	100	-0.01
19	660	550	550	495	465	130	100	100	-0.01
20	620	505	510	450	430	130	100	100	-0.01

THIRD FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	31	32U	32L	33U	33L	34U	34L	35	
1	75	75	85	85	85	85	85	85	0.01
2	75	75	85	85	85	85	85	85	0.02
3	75	75	85	85	85	85	85	85	0.03
4	80	75	85	85	85	85	85	85	0.04
5	80	80	85	85	85	85	85	85	0.04
6	80	80	85	85	85	85	85	85	0.03
7	80	80	85	85	85	85	85	85	0.03
8	80	80	85	85	85	85	85	85	0.02
9	85	80	85	85	85	85	85	85	0.06
10	165	125	105	85	115	90	85	110	0.11
11	275	175	145	90	115	105	95	125	0.05
12	405	250	175	100	115	120	105	155	0.02
13	450	285	195	105	120	125	110	170	0.02
14	495	335	220	115	115	145	120	190	0.02
15	500	330	245	120	120	150	125	195	0.02
16	520	345	255	125	125	160	130	205	0.02
17	515	350	260	125	130	165	135	205	0.02
18	500	340	260	130	135	165	135	200	0.02
19	480	340	265	130	135	165	140	205	0.02
20	455	350	265	130	140	170	145	215	0.02

**Test E-10**

**Date:** April 24, 1959

**Outdoor Temperature:** 66° F   **Humidity:** 54%   **Wind:** 6.3  
m.p.h. W Average

**Fuel:** 1,400 pounds of pallets

**Location of Test Fire:** Base of stairway No. 2

**Automatic Sprinklers:** None

**Vents:** 42 square feet at top of stairway No. 2

**Curtain Boards:** Corridors and stairway openings to corridors

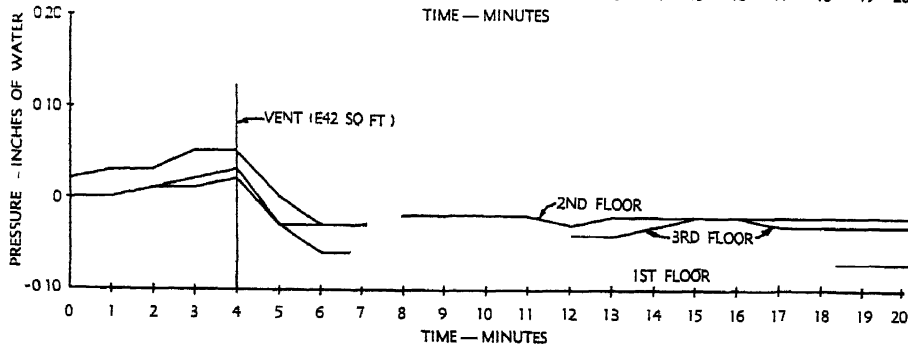
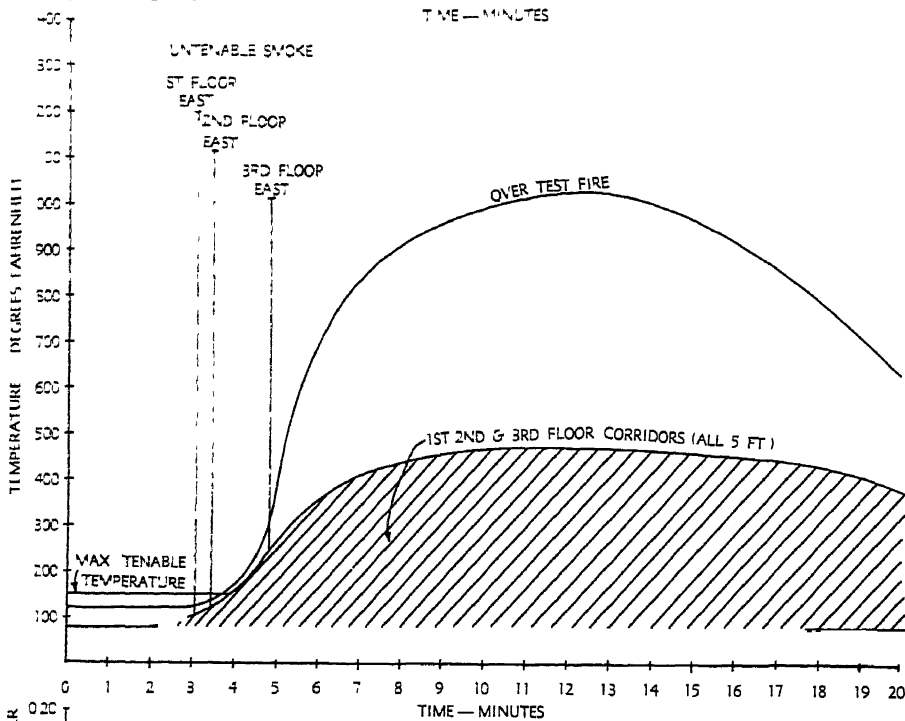
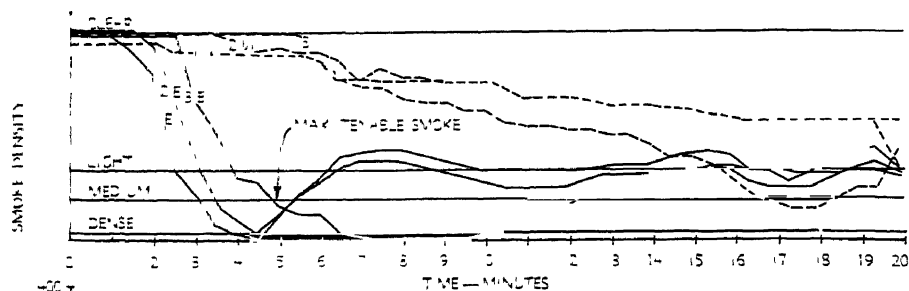
**Automatic Fire Detection:** Coverage as shown in Figure 12

**Other:** Vent opened when temperature at thermocouple nearest test fire reached 200 degrees Fahrenheit. Two doors hung with spring loaded hinges installed in partition at curtain board in all corridors; one door opening in each direction.

**Comments:**

Earlier operation of vent than in Test E-9 prevented pressures developing sufficiently to open doors in corridors.

East end of first and second floor corridors cleared quickly after vent was opened.



## Automatic Fire Detection System

Circuit No.	Area Covered	Response Time from Fire Start	
		Minutes	Seconds
1	1st Floor Corridor	3	45
2	2nd Floor Corridor	4	20
3	3rd Floor Corridor	5	23
4	Room 203	4	37
5	Stairway No 2	3	19
6	Stairway No 1	4	32

## Temperature and Pressure Readings

FIRST FLOOR								
Time Min- utes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11	12U	12L	13U	13L	14U	14L	
1	120	90	85	90	90	85	75	0.00
2	125	95	90	95	90	85	75	0.01
3	130	105	95	95	95	85	75	0.01
4	150	130	110	100	100	85	75	0.02
5	340	320	290	125	115	90	75	-0.03
6	840	400	360	250	220	90	75	-0.06
7	840	405	400	310	250	90	75	-0.06
8	865	430	415	350	280	95	75	-0.06
9	905	460	440	370	300	95	75	-0.06
10	955	460	450	385	320	100	75	-0.07
11	995	475	465	400	350	100	75	-0.07
12	1050	485	465	415	360	105	75	-0.07
13	1020	465	435	420	370	105	80	-0.07
14	970	465	420	420	350	105	80	-0.07
15	930	440	420	405	340	105	80	-0.07
16	915	440	425	395	330	105	80	-0.07
17	875	435	405	395	330	105	80	-0.07
18	785	400	365	395	350	105	80	-0.07
19	745	355	360	370	330	100	80	-0.07
20	555			340	300	100		-0.07

## Temperature and Pressure Readings

SECOND FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	21	22U	22L	23U	23L	24U	24L	25	
1	105	95	90	100	100	80	80	80	0.03
2	105	100	90	100	100	80	80	80	0.03
3	115	100	95	100	100	80	80	80	0.05
4	145	115	95	100	100	85	85	85	0.05
5	325	240	185	110	110	85	85	85	0.00
6	450	355	315	200	180	90	80	80	-0.03
7	470	385	340	250	230	95	80	80	-0.03
8	490	400	355	310	240	100	80	80	-0.02
9	515	420	380	345	320	105	80	80	-0.02
10	530	440	420	365	340	110	80	80	-0.02
11	555	435	450	385	355	110	85	85	-0.02
12	565	470	465	405	370	115	85	85	-0.03
13	565	465	470	515	380	120	85	85	-0.02
14	545	450	470	420	385	135	85	85	-0.02
15	560	450	465	410	380	125	85	85	-0.02
16	565	450	465	400	350	125	85	85	-0.02
17	515	425	445	405	300	130	90	90	-0.02
18	465	400	415	395	370	130	90	85	-0.02
19	435	375	385	375	355	130	95	90	-0.02
20				360	335	130	90	90	-0.02

THIRD FLOOR									
Time Minutes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	31	32U	32L	33U	33L	34U	34L	35	
1	95	90	90	80	80	80	80	80	0.00
2	95	90	90	80	80	80	80	80	0.01
3	100	95	90	80	80	80	80	80	0.02
4	110	100	95	80	80	80	80	80	0.03
5	205	110	95	80	80	80	80	80	-0.03
6	290	160	100	80	80	80	80	80	-0.03
7	325	185	115	80	80	80	80	80	-0.03
8	335	195	135	90	85	85	80	85	-0.03
9	365	210	150	100	85	90	85	85	-0.03
10	380	220	165	100	85	90	85	85	-0.03
11	400	230	175	105	85	95	85	85	-0.03
12	405	235	180	110	90	100	90	90	-0.04
13	410	235	190	110	95	100	90	90	-0.04
14	405	255	195	110	90	100	90	90	-0.03
15	405	255	200	105	90	100	90	90	-0.02
16	410	255	200	105	95	105	95	90	-0.02
17	390	245	205	120	95	105	95	95	-0.03
18	375	245	205	115	100	105	95	95	-0.03
19	345	235	205	115	100	105	95	95	-0.03
20			200	105	100	105	95	95	-0.03

## Series F

### Vents and Curtain Boards — Summer Conditions

This series like the E Series was conducted to determine the effectiveness of a combination of vents and curtain boards except that this series attempts to simulate conditions within the building that could be prevalent during summer months and during evacuation of the building under fire conditions.

#### Test F-1

**Date:** May 21, 1959

**Outdoor Temperature:** 67° F. **Humidity:** 61% **Wind:** 6.5 m.p h. S Average

**Fuel:** 1,400 pounds of pallets

**Location of Test Fire:** Base of stairway No. 2

**Automatic Sprinklers:** None

**Vents:** 42 square feet at top of stairway No. 2

**Curtain Boards:** Corridors and stairway openings to corridors

**Automatic Fire Detection:** None

**Other:** Vent opened when temperature at thermocouple nearest test fire reached 200 degrees Fahrenheit. Exit doors at west end of first floor corridor opened 30 seconds after vent opened. Fusible links (135 degree Fahrenheit rating) suspended at the 7 foot level in each corridor opening to the stairways. Center of both stairways opened to provide unobstructed passage to the top.

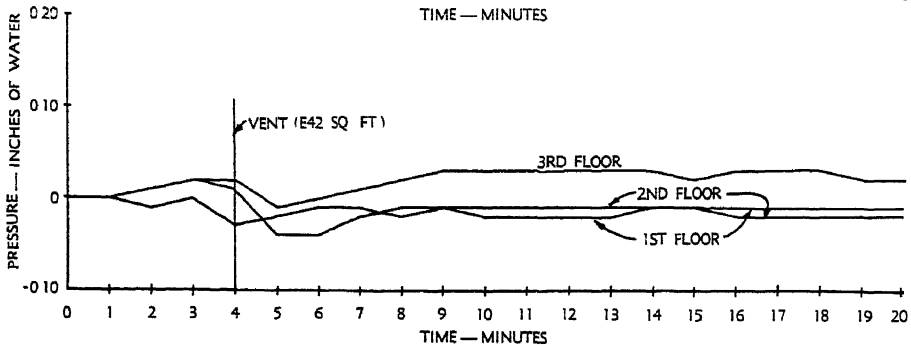
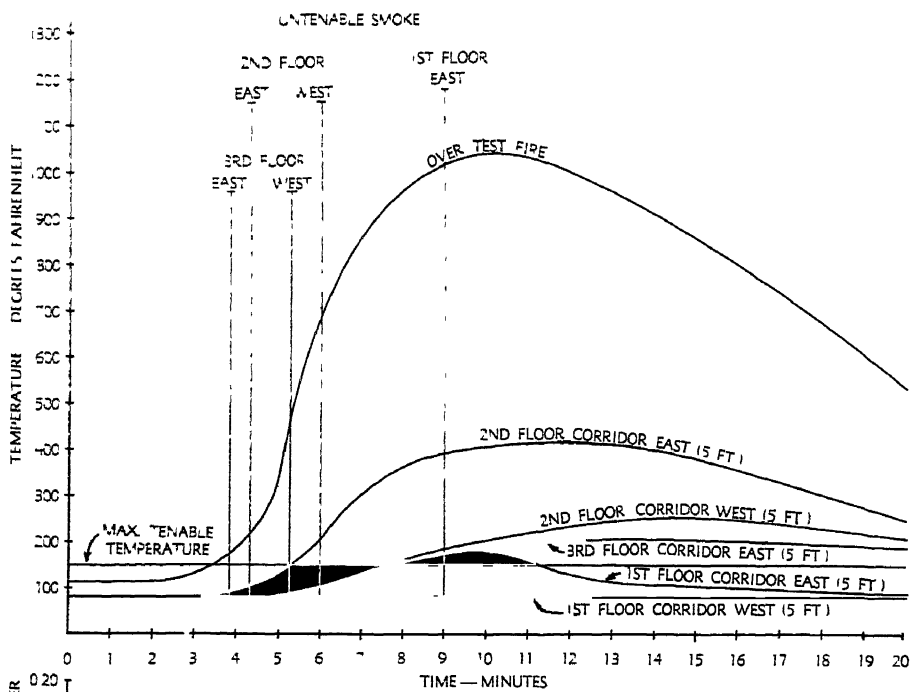
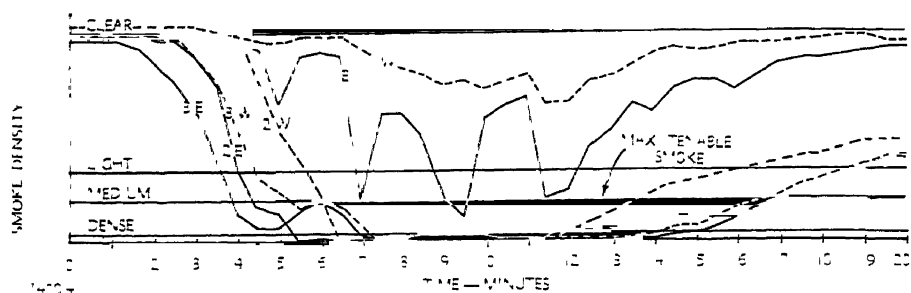
#### Comments:

First floor corridor stayed tenable from smoke during entire test, particularly the west end

Maximum tenable temperatures in the second floor corridor were reached about one minute after untenable smoke conditions at the east side of the curtain board

The fusible links installed in the corridor openings fused as follows:

	<i>Stairway No. 2</i>	<i>Stairway No. 1</i>
1st Floor	4½ minutes	Did not fuse
2nd Floor	5 minutes	7 minutes
3rd Floor	5½ minutes	8 minutes



# Temperature and Pressure Readings

FIRST FLOOR								
Time Min- utes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11	12U	12L	13U	13L	14U	14L	
1	110	100	90	110	95	95	85	0.00
2	115	100	90	110	100	100	85	-0.01
3	125	100	85	110	100	100	85	0.00
4	180	105	90	110	100	100	80	-0.03
5	320	130	95	115	100	100	85	-0.02
6	710	150	90	125	100	100	85	-0.01
7	905	310	155	165	165	100	85	-0.01
8	920	375	185	225	225	125	90	-0.02
9	980	375	205	265	230	145	100	-0.01
10	980	375	175	230	290	150	105	-0.02
11	1070	370	165	260	230	155	95	-0.02
12	1060	335	125	265	290	150	90	-0.02
13	950	290	105	270	175	125	85	-0.02
14	885	275	105	255	150	105	85	-0.01
15	815	245	105	235	105	100	85	-0.01
16	730	230	100	220	105	100	85	-0.01
17	705	220	95	215	95	95	85	-0.01
18	635	215	90	200	90	95	85	-0.01
19	610	200	90	200	90	95	80	-0.01
20	545	195	90	190	90	95	80	-0.01

SECOND FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	21	22U	22L	23U	23L	24U	24L	25	
1	100	90	90	100	95	95	95	95	0.00
2	100	90	90	100	95	95	95	95	0.01
3	105	95	90	100	95	95	95	95	0.02
4	130	120	95	100	100	100	95	95	0.01
5	200	215	130	115	110	105	95	95	-0.04
6	300	315	210	190	175	155	105	95	-0.04
7	450	385	325	300	250	220	125	100	-0.02
8	500	400	370	340	320	270	165	120	-0.01
9	515	400	390	365	350	285	190	130	-0.01
10	550	430	390	370	350	290	200	135	-0.01
11	560	440	420	385	375	320	215	140	-0.01
12	560	435	420	405	385	315	230	135	-0.01
13	525	405	410	390	385	320	245	130	-0.01
14	495	385	395	365	355	305	250	145	-0.01
15	455	360	380	355	345	295	250	150	-0.01
16	425	340	340	335	325	285	240	160	-0.02
17	390	320	320	310	305	265	230	155	-0.02
18	360	310	290	300	290	255	220	150	-0.02
19	330	280	280	285	280	250	215	150	-0.02
20	315	275	255	270	260	225	205	140	-0.02

### Temperature and Pressure Readings

THIRD FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	31	32U	32L	33U	33L	34U	34L	35	
1	90	90	100	90	100	95	95	95	0.00
2	95	90	100	90	100	95	95	95	0.01
3	105	95	100	95	100	95	95	95	0.02
4	140	105	105	95	100	95	95	95	0.02
5	170	115	110	100	105	100	100	100	-0.01
6	215	125	110	105	105	110	100	105	0.00
7	275	150	115	115	110	135	115	125	0.01
8	320	165	125	130	125	170	130	180	0.02
9	290	180	150	155	150	190	165	200	0.03
10	295	185	155	165	160	200	170	205	0.03
11	285	185	170	175	170	210	190	220	0.03
12	255	190	175	185	180	220	200	230	0.03
13	240	185	175	190	190	225	205	235	0.03
14	250	185	180	195	195	225	205	235	0.03
15	210	185	180	200	200	225	205	230	0.02
16	205	180	175	195	195	215	205	225	0.03
17	200	175	170	190	190	210	200	220	0.03
18	190	175	170	190	190	200	195	210	0.03
19	180	170	170	185	185	200	190	205	0.02
20	180	170	165	180	180	195	185	195	0.02

## Test F-2

**Date:** May 22, 1959

**Outdoor Temperature:** 66° F   **Humidity:** 61%   **Wind:** 8.6 m.p.h. S Average

**Fuel:** 1,400 pounds of pallets

**Location of Test Fire:** Base of stairway No 2

**Automatic Sprinklers:** None

**Vents:** 42 square feet at top of stairway No. 2; 42 square feet at top of stairway No 1

**Curtain Boards:** Corridors and stairway openings to corridors

**Automatic Fire Detection:** None

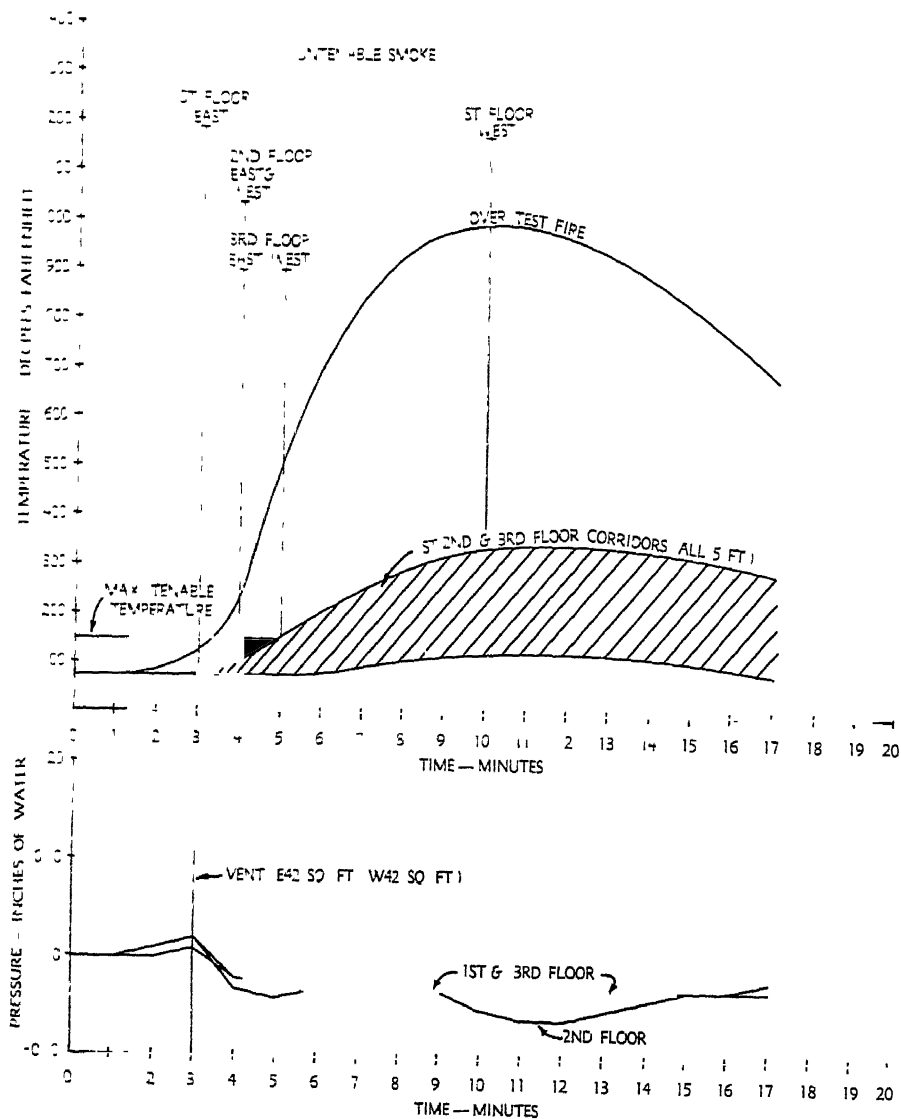
**Other:** Vents opened when temperature at thermocouple nearest test fire reached 150 degrees Fahrenheit   Exit doors at west end of first floor corridor opened 30 seconds after vents   Both stairways opened to provide an unobstructed passage to the top. No smoke density readings taken during this test. Reports of smoke conditions from observers only.

### Comments:

Untenable smoke conditions resulted in second and third floor corridors immediately after vents were opened. West end of second floor corridor cleared in 2 minutes after vents opened.

Maximum tenable temperature never reached at west end of first floor corridor.

Curtain boards did delay heat travel to west end of building.



## Temperature and Pressure Readings

FIRST FLOOR								
Time Min- utes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11	12U	12L	13U	13L	14U	14L	
1	75	75	75	75	75	75	75	0.00
2	90	80	85	90	140	80	75	0.01
3	120	85	80	80	100	80	75	0.02
4	230	100	85	90	90	30	75	-0.02
5	570	145	90	110	100	80	75	-0.03
6	700	255	180	150	160	100	80	-0.03
7	790	265	135	195	170	105	90	-0.03
8	945	350	190	255	280	140	125	-0.03
9	970	320	160	265	275	140	90	-0.03
10	945	355	195	255	250	115	105	-0.03
11	990	405	235	310	340	115	135	-0.03
12	1060	355	170	300	255	130	105	-0.03
13	905	345	150	280	240	115	105	-0.03
14	895	320	145	260	210	110	95	-0.03
15	830	300	135	250	210	110	90	-0.03
16	780	230	95	230	155	100	85	-0.03
17	680	230	115	215	155	90	80	-0.02
18								
19								
20								

[illegible]



### Test F-3

**Date:** May 22, 1959

**Outdoor Temperature:** 64° F   **Humidity:** 61%   **Wind:** 8.6  
m p h S Average

**Fuel:** 1,400 pounds of pallets

**Location of Test Fire:** Base of stairway No. 2

**Automatic Sprinklers:** None

**Vents:** 42 square feet at top of stairway No. 2; 42 square feet  
at top of stairway No. 1

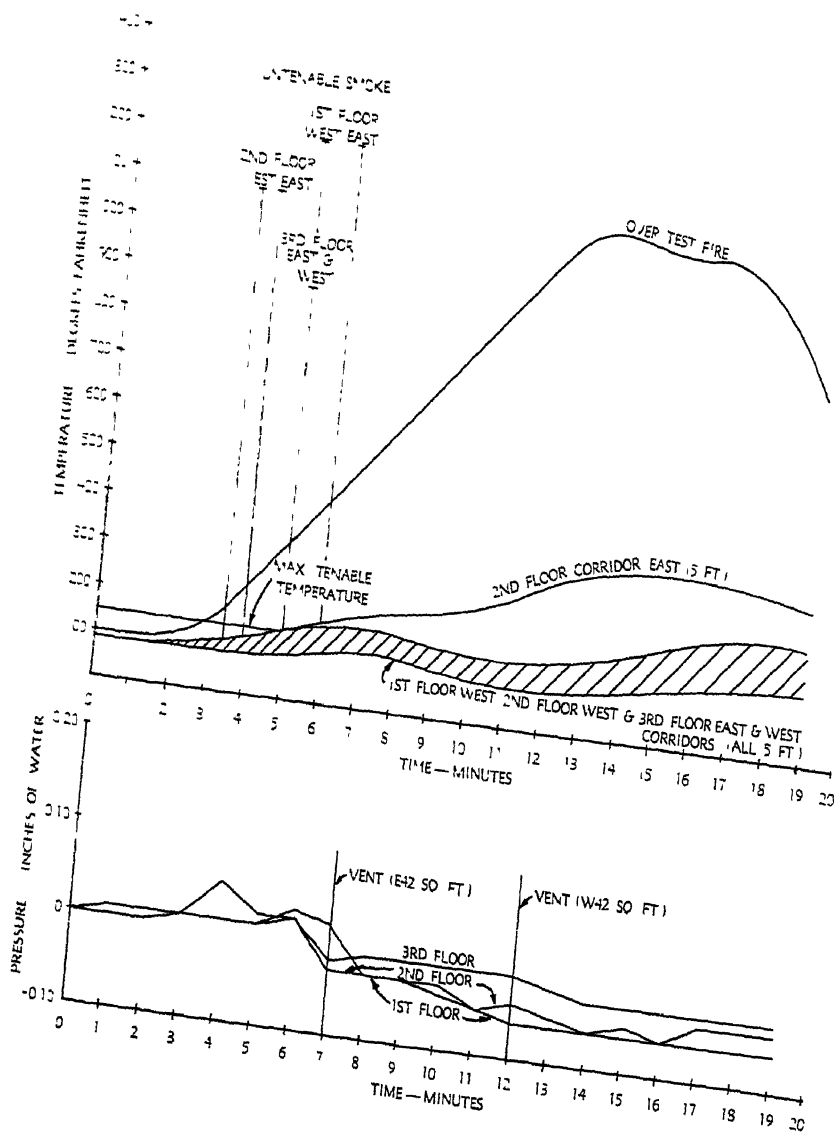
**Curtain Boards:** Corridors and stairway openings to corridors

**Automatic Fire Detection:** None

**Other:** Vents opened by operation of fusible links rated at 165 degrees Fahrenheit. Exit doors at west end of first floor corridor opened 30 seconds after vent over stairway No. 2 opened. Both stairways opened to produce an unobstructed passage to the top. No smoke density readings taken during this test. Reports of smoke conditions from observers only.

#### Comments:

All corridors tenable for the first 3½ minutes of test. Smoke in second and third floor corridors became very dense immediately following opening of vent at the top of stairway No. 2. Corridors cleared relatively fast after vents were opened. Vent over stairway No. 2 opened in 7 minutes. Vent over stairway No. 1 opened in 12 minutes.



## Temperature and Pressure Readings

FIRST FLOOR								
Time Minutes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11	12U	12L	13U	13L	14U	14L	
1	105	85	85	90	90	90	80	0.00
2	110	90	85	90	90	90	80	0.00
3	145	115	90	95	90	90	80	0.01
4	235	135	95	100	100	85	85	0.01
5	330	150	105	110	105	90	85	0.01
6	470	225	175	120	120	95	110	0.03
7	530	265	195	145	155	165	125	0.02
8	565	235	120	195	210	135	120	-0.03
9	710	230	120	190	135	120	130	-0.03
10	790	260	165	200	185	110	100	-0.04
11	910	315	230	235	240	135	115	-0.05
12	1030	335	190	225	275	150	135	-0.04
13	1080	310	110	255	225	145	95	-0.06
14	1060	360	135	235	215	100	100	-0.06
15	1055	420	245	395	315	135	125	-0.08
16	1050	400	185	310	325	165	130	-0.06
17	1115	410	170	305	315	155	125	-0.04
18	1135	390	255	300	305	140	120	-0.04
19	790	385	435	320	325	135	155	-0.04
20								

[illegible]



**Test F-4**

**Date:** April 22, 1959

**Outdoor Temperature:** 71° F   **Humidity:** 62%   **Wind:** 4.7  
m.p.h. W Average

**Fuel:** 1,400 pounds of solid pallets

**Location of Test Fire:** Base of stairway No. 2

**Automatic Sprinklers:** None

**Vents:** 63 square feet at top of stairway No. 2

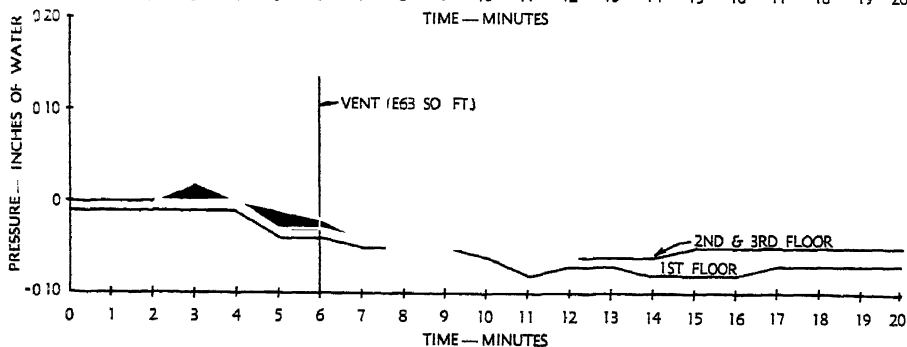
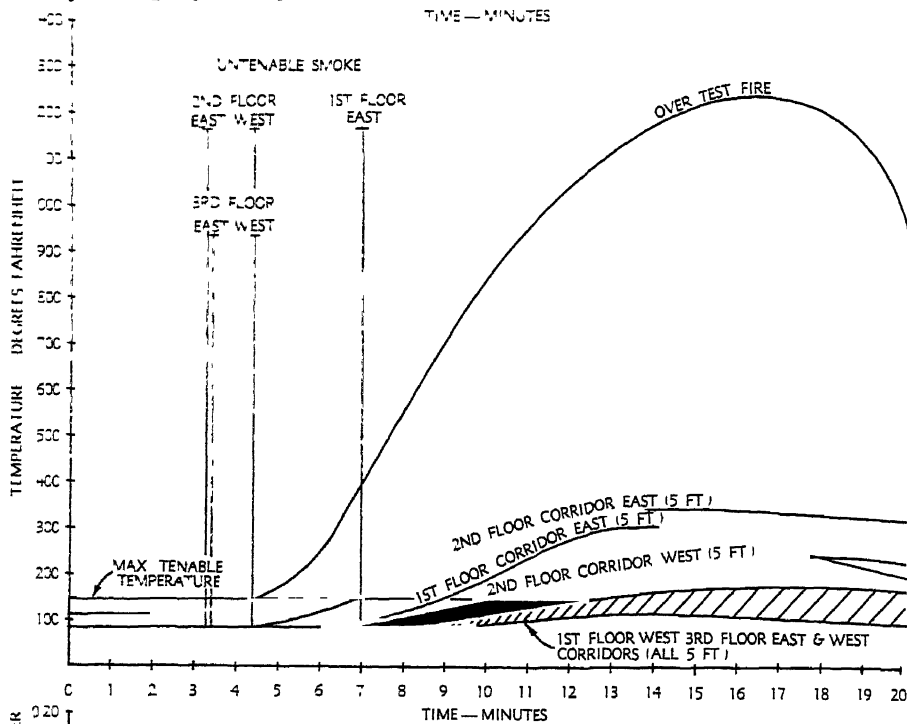
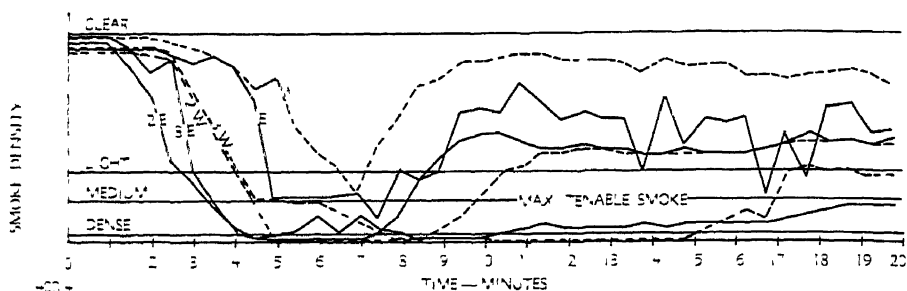
**Curtain Boards:** Corridors and stairway opening to corridors

**Automatic Fire Detection:** Coverage as shown in Figure 12

**Other:** Vent opened when temperature at thermocouple nearest  
test fire reached 200 degrees Fahrenheit. Exit doors at west  
end of first floor corridor opened 1 minute after vent opened.

**Comments:**

Vent cleared first and second floor corridors quickly but  
had no effect on the third floor corridor. Second and third  
floor corridors untenable due to smoke before vent opened.



## Automatic Fire Detection System

Circuit No.	Area Covered	Response Time from Fire Start	
		Minutes	Seconds
1	1st Floor Corridor	6	50
2	2nd Floor Corridor	7	5
3	3rd Floor Corridor	10	50
4	Room 203	8	5
5	Stairway No. 2	4	50
6	Stairway No. 1	7	20

## Temperature and Pressure Readings

FIRST FLOOR								
Time Minutes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11	12U	12L	13U	13L	14U	14L	
1	115	90	90	95	95	95	85	0.00
2	115	90	90	95	95	95	85	0.00
3	130	90	90	95	95	95	85	0.00
4	130	95	90	100	95	95	85	0.00
5	150	100	90	100	95	95	85	-0.01
6	210	120	105	100	100	95	85	-0.02
7	500	150	110	120	105	100	85	-0.04
8	650	190	125	130	110	95	85	-0.05
9	750	240	150	165	120	100	90	-0.05
10	900	290	185	200	170	105	100	-0.06
11	985	360	235	240	210	120	110	-0.08
12	1080	380	270	280	240	140	110	-0.07
13	1080	415	300	310	260	150	115	-0.07
14	1150	440	345	340	270	170	115	-0.08
15	1175	400	310	335	290	180	110	-0.08
16	1210	335	225	335	230	170	100	-0.08
17	1230	335	210	285	205	150	110	-0.07
18	1205	320	250	310	240	150	105	-0.07
19	950	315	205	280	200	150	100	-0.07
20	955	290	195	255	180	135	100	-0.07

# Temperature and Pressure Readings

SECOND FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	21	22U	22L	23U	23L	24U	24L	25	
1	100	100	90	95	95	95	90	90	0.00
2	100	100	90	95	95	95	90	90	0.00
3	103	100	90	95	95	95	90	90	0.02
4	105	100	95	100	100	95	90	90	0.00
5	110	105	95	100	100	95	90	90	-0.03
6	140	125	105	100	100	95	90	90	-0.03
7	245	190	150	140	120	115	100	100	-0.04
8	310	225	200	160	145	135	105	100	-0.05
9	315	275	230	205	180	175	125	100	-0.05
10	425	320	275	250	220	205	150	115	-0.05
11	490	360	335	295	250	240	170	110	-0.05
12	520	390	325	320	285	260	195	110	-0.06
13	535	420	325	340	305	280	205	120	-0.06
14	535	430	335	350	320	295	215	125	-0.06
15	595	440	350	360	330	310	225	125	-0.05
16	530	435	340	360	335	310	230	115	-0.05
17	505	425	340	355	330	310	235	110	-0.05
18	510	415	340	355	325	310	240	115	-0.05
19	455	385	325	345	315	300	235	110	-0.05
20	410	355	315	320	300	280	225	110	-0.05

THIRD FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	31	32U	32L	33U	33L	34U	34L	35	
1	95	90	90	90	90	90	90	90	-0.01
2	95	90	95	90	90	90	90	90	-0.01
3	95	90	95	90	95	90	90	90	-0.01
4	95	95	100	90	95	90	90	90	-0.01
5	100	95	100	90	95	90	90	90	-0.04
6	115	95	100	90	95	90	90	95	-0.04
7	170	95	100	90	95	90	90	100	-0.05
8	195	100	95	90	100	90	90	100	-0.05
9	225	105	100	90	105	110	90	130	-0.05
10	255	110	105	110	120	120	110	150	-0.05
11	280	115	110	120	140	140	125	165	-0.05
12	305	125	120	135	140	150	140	180	-0.06
13	300	130	130	150	150	160	155	190	-0.06
14	305	140	190	155	155	165	160	200	-0.06
15	305	140	140	165	160	165	165	205	-0.05
16	315	150	150	165	170	175	165	215	-0.05
17	305	150	150	175	170	180	175	220	-0.05
18	305	155	150	175	170	180	175	215	-0.05
19	280	155	150	175	170	180	175	215	-0.05
20	260	155	150	175	165	180	175	210	-0.05

**Test F-5**

**Date:** April 23, 1959

**Outdoor Temperature:** 74° F. **Humidity:** 66% **Wind:** 5.5  
m.p.h W Average

**Fuel:** 1,400 pounds of pallets

**Location of Test Fire:** Base of stairway No. 2

**Automatic Sprinklers:** None

**Vents:** 63 square feet at top of stairway No. 2; 63 square feet at  
top of stairway No 1

**Curtain Boards:** Corridors and stairway openings to corridors

**Automatic Fire Detection:** Coverage as shown in Figure 12

**Other:** Vents opened when temperature at thermocouple nearest  
test fire reached 150 degrees Fahrenheit. Exit doors at west  
end of first floor corridor opened 1 minute after vents.

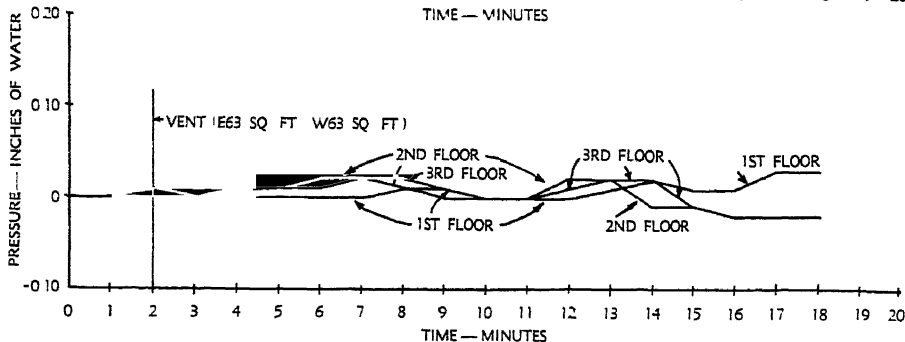
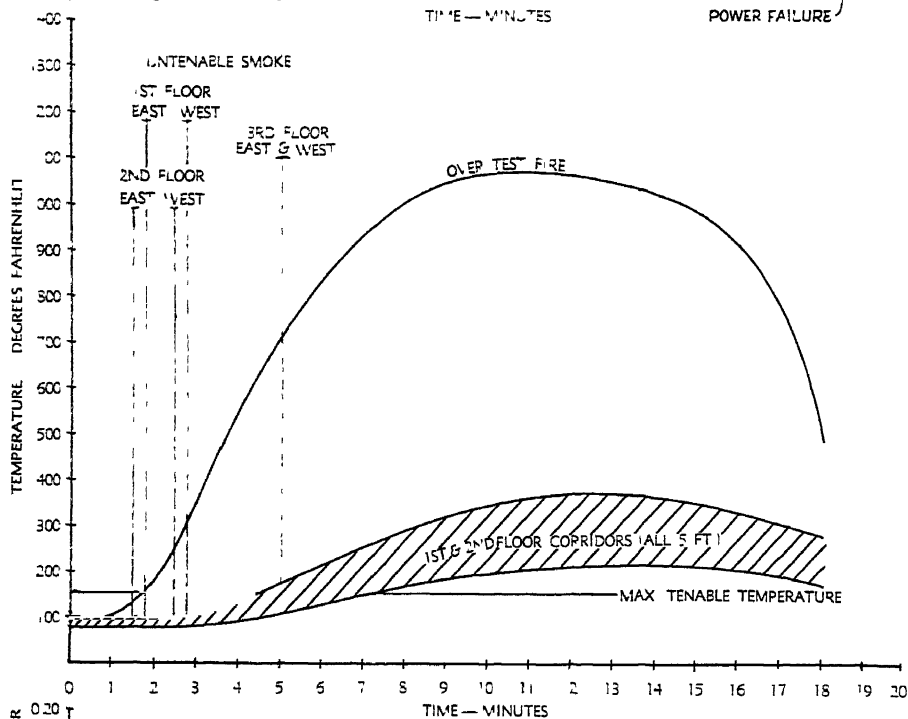
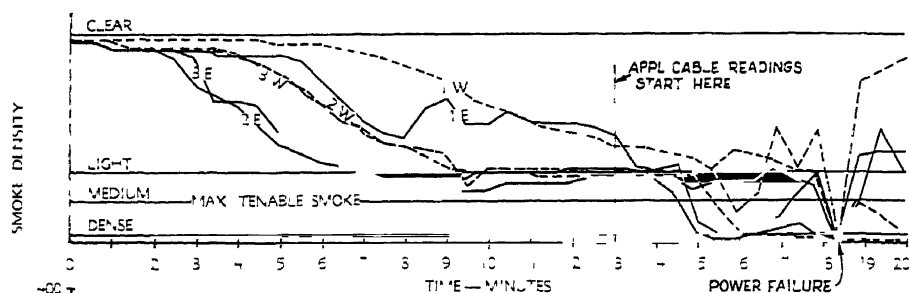
**Comments:**

Test fire did not start to develop until 13 minutes had  
passed.

All recorded data, except smoke density readings, taken  
after 13 minute period.

Vents cleared smoke in first and second floor corridors  
although untenable smoke conditions existed at the east end  
of both corridors before vents were opened.

Temperatures in the first and second floor corridors  
exceeded the maximum tenable temperature during the  
period when smoke was clearing in those corridors, except at  
the west end of the first floor corridor.



## Automatic Fire Detection System

Circuit No.	Area Covered	Response Time from Fire Start	
		Minutes	Seconds
1	1st Floor Corridor	15	55
2	2nd Floor Corridor	15	15
3	3rd Floor Corridor	19	18
4	Room 203	16	37
5	Stairway No. 2	15	20
6	Stairway No. 1	15	21

Note: Test fire showed no reading on thermocouples for 13 minutes.

## Temperature and Pressure Readings

FIRST FLOOR								
Time Min- utes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11	12U	12L	13U	13L	14U	14L	
1	110	75	75	90	90	90	75	0.00
2	130	75	75	90	90	90	75	0.00
3	350	125	100	105	100	90	75	0.00
4	500	185	130	140	130	100	75	0.00
5	600	225	125	165	160	110	75	0.00
6	815	330	230	240	230	140	110	0.00
7	960	325	230	260	260	150	110	0.00
8	935	350	270	280	255	150	110	0.01
9	1055	350	250	290	280	160	110	0.01
10	1060	380	280	300	285	165	110	0.00
11	1085	405	280	325	305	180	120	0.00
12	1050	375	285	315	300	180	115	0.00
13	1030	395	300	320	300	180	115	0.01
14	1015	375	290	315	295	180	115	0.02
15	1005	335	235	300	270	180	115	-0.01
16	915	295	200	270	225	145	105	-0.01
17	850	285	195	250	215	130	100	-0.03
18	495	285	175	240	210	125	100	-0.03
19								
20								



**Test F-6**

**Date:** April 23, 1959

**Outdoor Temperature:** 69° F. **Humidity:** 66% **Wind:** 5.5  
m p.h. W Average

**Fuel:** 1,400 pounds of pallets

**Location of Test Fire:** Base of stairway No 2

**Automatic Sprinklers:** None

**Vents:** 63 square feet at top of stairway No 2

**Curtain Boards:** Corridors and stairway openings to corridors

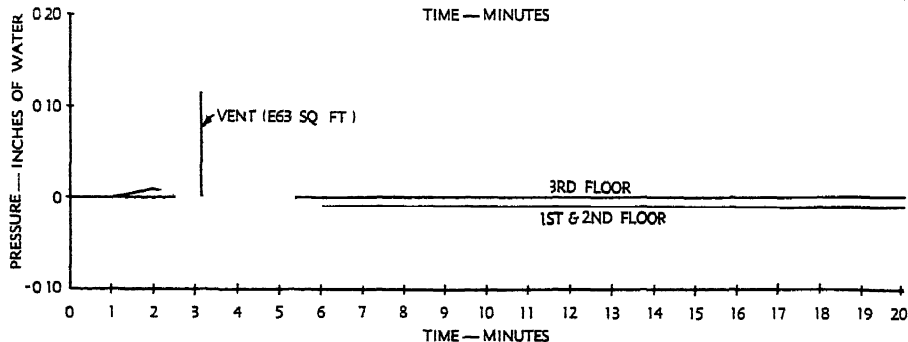
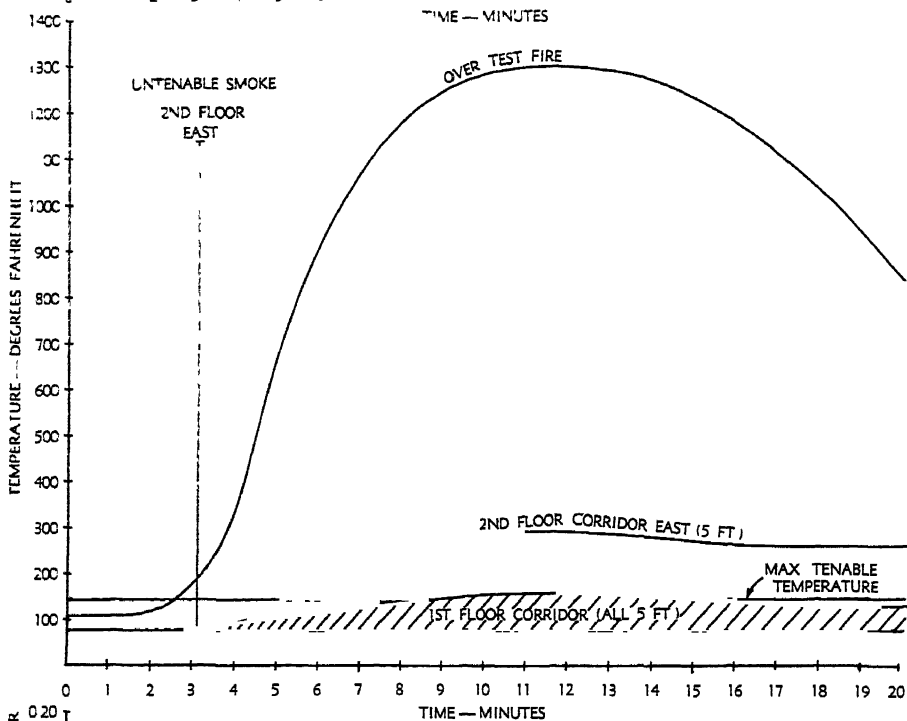
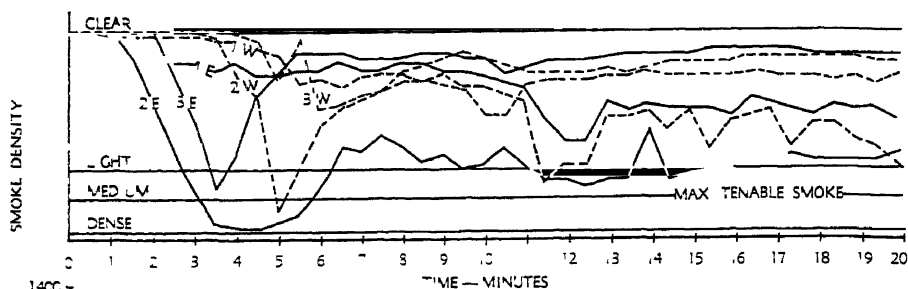
**Automatic Fire Detection:** Coverage as shown in Figure 12

**Other:** Vent opened when temperature at thermocouple nearest  
test fire reached 200 degrees Fahrenheit Classroom doors,  
windows and transoms open Exit doors at west end of first  
floor corridor open

**Comments:**

Only the east end of the second floor corridor became untenable from smoke and then only for 3 minutes.

Temperatures at the 5 foot level at the east end of the second floor corridor exceeded the maximum tenable level in 5 to 6 minutes.



## Automatic Fire Detection System

Circuit No.	Area Covered	Response Time from Fire Start	
		Minutes	Seconds
1	1st Floor Corridor	3	0
2	2nd Floor Corridor	2	55
3	3rd Floor Corridor	No response.	
4	Room 203	4	35
5	Stairway No 2	2	33
6	Stairway No 1	4	15

## Temperature and Pressure Readings

FIRST FLOOR								
Time Min- utes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11	12U	12L	13U	13L	14U	14L	
1	105	85	80	85	85	85	75	0.00
2	115	85	80	85	85	85	75	0.01
3	165	85	80	85	85	85	75	0.00
4	310	85	80	100	90	85	75	0.00
5	875	95	85	130	95	85	75	0.00
6	1000	175	105	185	105	90	75	-0.01
7	1040	255	110	225	105	105	75	-0.01
8	1050	305	120	230	105	115	75	-0.01
9	1175	300	130	245	110	125	80	-0.01
10	1260	335	130	260	110	130	80	-0.01
11	1325	315	165	270	115	135	85	-0.01
12	1345	355	105	280	125	145	85	-0.01
13	1275	375	195	285	125	150	90	-0.01
14	1205	345	165	260	100	150	90	-0.01
15	1235	295	130	260	115	145	85	-0.01
16	1220	300	135	260	110	140	85	-0.01
17	1160	290	115	250	110	135	80	-0.01
18	1040	285	130	265	110	135	80	-0.01
19	950	350	145	265	110	140	80	-0.01
20	845	315	145	260	115	145	80	-0.01

# Temperature and Pressure Readings

SECOND FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	21	22U	22L	23U	23L	24U	24L	25	
1	90	80	90	90	85	85	85	85	0.00
2	90	80	80	90	90	85	85	85	0.00
3	90	80	80	90	90	85	85	85	0.00
4	110	105	90	110	105	90	85	85	0.00
5	155	120	100	150	145	115	90	85	0.00
6	280	220	150	210	195	115	100	85	-0.01
7	390	300	180	250	230	180	110	90	-0.01
8	445	345	255	265	240	190	110	90	-0.01
9	495	385	260	290	250	210	115	90	-0.01
10	505	385	270	310	260	225	120	90	-0.01
11	525	405	290	320	270	235	125	90	-0.01
12	490	415	295	325	275	235	130	95	-0.01
13	530	410	305	325	275	230	130	100	-0.01
14	515	400	295	320	275	230	130	95	-0.01
15	505	385	265	320	275	230	125	90	-0.01
16	505	405	270	320	275	225	125	90	-0.01
17	495	395	270	315	275	230	130	90	-0.01
18	460	390	255	310	265	230	130	90	-0.01
19	470	375	285	305	260	225	130	90	-0.01
20	450	365	285	300	255	215	125	90	-0.01

THIRD FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	31	32U	32L	33U	33L	34U	34L	35	
1	90	80	90	85	85	85	85	85	0.00
2	90	80	95	85	85	85	85	85	0.00
3	90	80	95	85	85	85	85	85	0.00
4	100	90	100	85	85	85	85	85	0.00
5	110	95	95	85	85	85	85	85	0.00
6	165	95	90	85	85	85	85	95	0.00
7	170	95	90	90	90	95	95	105	0.00
8	185	80	90	90	90	95	95	110	0.00
9	205	80	90	90	90	100	95	115	0.00
10	220	80	90	100	95	100	95	125	0.00
11	220	85	90	100	100	105	100	125	0.00
12	225	90	95	100	100	105	100	120	0.00
13	225	90	95	100	100	100	100	120	0.00
14	210	90	90	100	100	100	100	120	0.00
15	210	85	90	100	100	100	100	120	0.00
16	215	85	90	100	100	100	100	120	0.00
17	205	85	90	100	100	100	100	120	0.00
18	205	85	90	100	100	100	100	120	0.00
19	200	85	90	100	100	100	100	120	0.00
20	200	85	90	100	100	100	100	120	0.00

**Test F-7**

**Date:** April 28, 1959

**Outdoor Temperature:** 80° F. **Humidity:** 36% **Wind:** 4.1  
m p h W Average

**Fuel:** 1,400 pounds of pallets

**Location of Test Fire:** Base of stairway No. 2

**Automatic Sprinklers:** None

**Vents:** 63 square feet at top of stairway No. 2; 63 square feet at  
top of stairway No. 1

**Curtain Boards:** Corridors only

**Automatic Fire Detection:** Coverage as shown in Figure 12

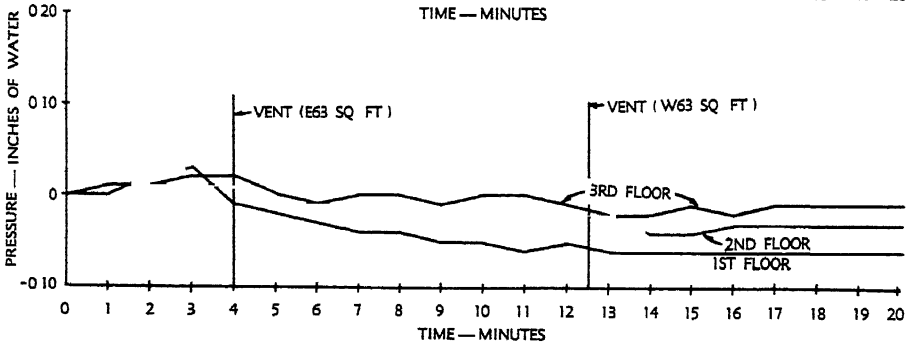
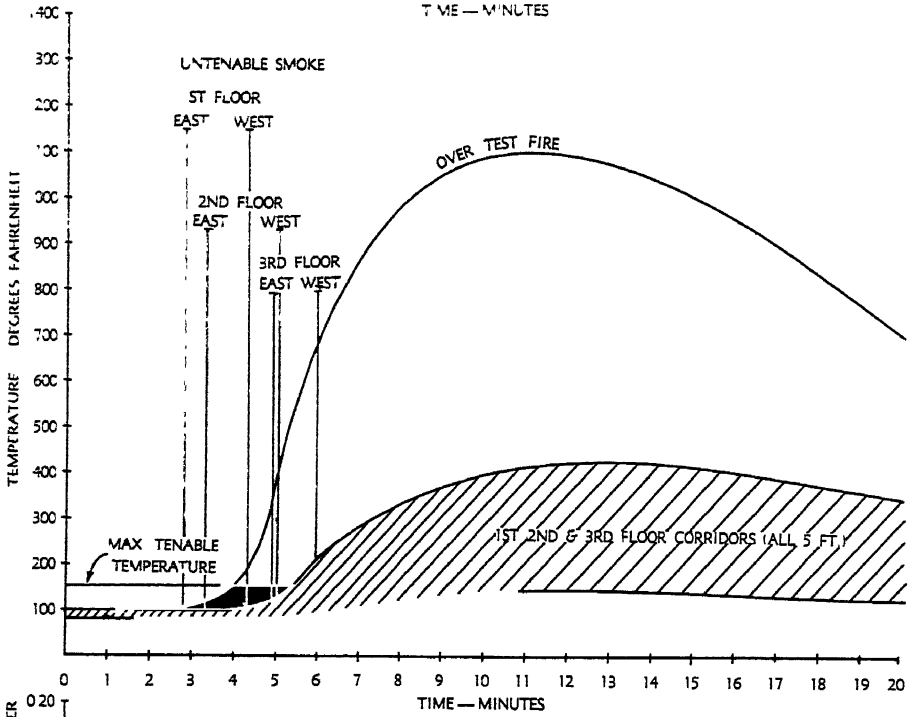
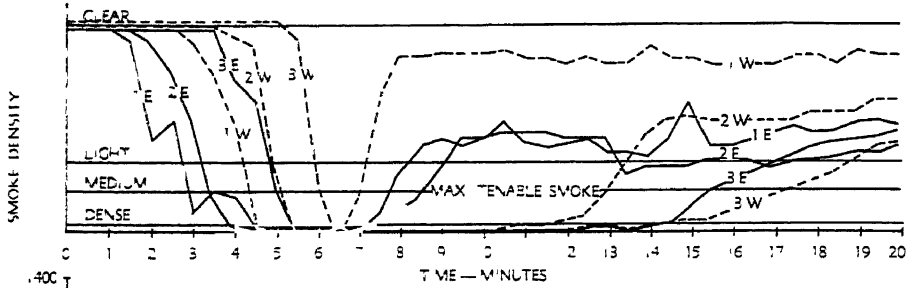
**Other:** Vent at stairway No. 2 opened when temperature at thermocouple nearest test fire reached 150 degrees Fahrenheit. Vent at stairway No. 1 opened on operation of fusible link rated at 165 degrees Fahrenheit. Exit doors at west end of first floor corridor opened 30 seconds after vent over stairway No. 2 opened

**Comments:**

Vents did not clear building until 3 minutes after operation and then only on first and second floors. Smoke became very dense immediately after vents opened.

Open doors and curtain board kept temperatures down at west end of first floor corridor.

Vent over stairway No. 1 opened in 12½ minutes.



## Automatic Fire Detection System

Circuit No.	Area Covered	Response Time from Fire Start	
		Minutes	Seconds
1	1st Floor Corridor	4	4
2	2nd Floor Corridor	5	19
3	3rd Floor Corridor	6	20
4	Room 203	5	35
5	Stairway No 2	4	40
6	Stairway No. 1	5	24

## Temperature and Pressure Readings

FIRST FLOOR								
Time Min- utes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11	12U	12L	13U	13L	14U	14L	
1	85	80	80	85	85	85	80	0.00
2	95	85	80	85	85	85	80	0.02
3	110	95	80	85	85	85	80	0.03
4	145	105	80	95	95	90	80	-0.01
5	295	235	100	125	115	95	80	-0.02
6	785	485	170	240	225	130	90	-0.03
7	905	595	185	355	325	180	110	-0.04
8	940	590	175	385	355	200	120	-0.04
9	955	640	180	400	350	200	125	-0.05
10	1020	700	205	430	385	210	125	-0.05
11	1110	755	180	450	405	215	125	-0.06
12	1160	770	245	480	430	230	135	-0.05
13	1125	800	240	490	430	210	135	-0.06
14	1080	770	250	505	440	185	135	-0.06
15	1000	725	175	475	400	150	125	-0.06
16	945	700	190	460	400	160	120	-0.06
17	890	665	175	440	395	160	125	-0.06
18	805	615	145	420	360	155	125	-0.06
19	750	605	160	410	360	155	125	-0.06
20	730	560	125	390	350	150	125	-0.06

## Temperature and Pressure Readings

SECOND FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	21	22U	22L	23U	23L	24U	24L	25	
1	80	80	80	85	85	85	85	85	0.01
2	80	80	80	85	85	85	85	85	0.01
3	80	80	80	85	85	85	85	85	0.01
4	90	85	80	85	85	85	85	85	0.01
5	120	100	80	90	90	90	85	85	-0.01
6	255	190	110	130	125	120	95	125	-0.01
7	350	275	165	195	180	180	120	170	-0.01
8	370	300	200	235	215	210	140	170	-0.01
9	385	325	230	245	230	220	145	165	-0.02
10	410	340	240	260	250	235	155	175	-0.02
11	425	360	260	280	265	250	165	175	-0.02
12	445	375	265	295	275	255	175	195	-0.02
13	445	380	295	305	290	270	180	185	-0.02
14	445	385	285	315	290	270	185	185	-0.04
15	425	365	285	310	290	265	180	155	-0.04
16	405	355	265	300	285	250	170	170	-0.03
17	385	340	265	295	280	250	170	165	-0.03
18	375	325	255	290	270	245	170	160	-0.03
19	360	315	245	280	260	235	165	165	-0.03
20	345	300	240	265	255	230	160	155	-0.03

THIRD FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	31	32U	32L	33U	33L	34U	34L	35	
1	85	80	85	85	85	85	85	95	0.01
2	85	80	85	85	85	85	85	95	0.01
3	85	80	85	85	85	85	85	95	0.02
4	85	80	85	85	85	85	85	95	0.02
5	90	80	85	85	85	85	85	90	0.00
6	140	125	95	90	90	100	95	105	-0.01
7	175	160	110	105	105	125	115	140	0.00
8	200	170	120	120	120	145	130	160	0.00
9	205	175	130	130	130	155	140	160	-0.01
10	230	165	140	140	140	160	150	170	0.00
11	240	160	150	145	145	170	160	180	0.00
12	245	175	150	150	150	170	160	185	-0.01
13	275	205	155	150	155	170	160	180	-0.02
14	285	240	175	170	155	165	160	175	-0.02
15	275	245	185	180	155	165	160	175	-0.01
16	275	240	185	180	155	165	160	165	-0.02
17	260	230	180	175	155	165	160	165	-0.01
18	250	225	185	180	155	165	160	165	-0.01
19	245	225	180	175	155	160	155	160	-0.01
20	225	215	170	165	150	155	150	160	-0.01

**Test F-8**

**Date:** April 28, 1959

**Outdoor Temperature:** 78° F   **Humidity:** 36%   **Wind:** 41  
m p h W Average

**Fuel:** 1,400 pounds of pallets

**Location of Test Fire:** Base of stairway No. 2

**Automatic Sprinklers:** None

**Vents:** 42 square feet at top of stairway No. 2; 42 square feet at  
top of stairway No. 1

**Curtain Boards:** Corridors only

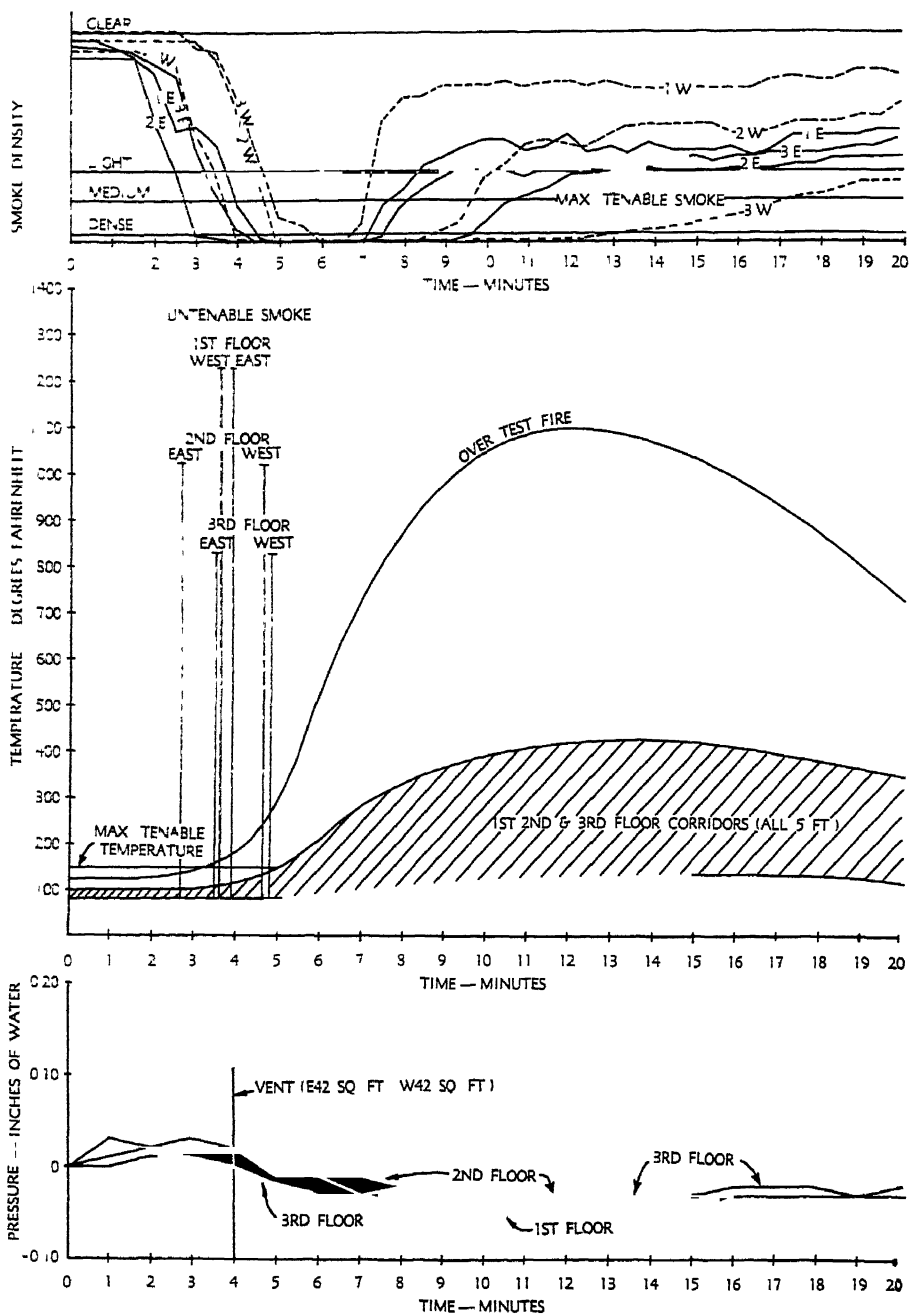
**Automatic Fire Detection:** Coverage as shown in Figure 12

**Other:** Vents opened when temperature at thermocouple nearest  
test fire reached 200 degrees Fahrenheit   Exit doors at west  
end of first floor corridor opened 30 seconds after vents.

**Comments:**

The east end of all corridors became untenable from smoke before vents operated. Vents did clear first and second floor corridors in 2 to 3 minutes but temperatures by that time were untenable in those corridors at the 5 foot level except at the west end of the first floor corridor.

Open exit doors and curtain board kept temperatures down in west end of first floor corridor.



## Automatic Fire Detection System

Circuit No.	Area Covered	Response Time from Fire Start	
		Minutes	Seconds
1	1st Floor Corridor	3	37
2	2nd Floor Corridor	4	12
3	3rd Floor Corridor	6	25
4	Room 203	5	58
5	Stairway No. 2	4	2
6	Stairway No. 1	4	17

## Temperature and Pressure Readings

FIRST FLOOR								
Time Min- utes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11	12U	12L	13U	13L	14U	14L	
1	120	95	90	105	100	100	80	0.01
2	125	105	90	105	100	100	80	0.02
3	135	120	90	110	105	100	80	0.03
4	180	150	95	115	110	100	85	0.02
5	280	240	120	140	130	110	90	-0.01
6	660	450	155	230	210	130	90	-0.01
7	805	575	185	340	315	175	100	-0.03
8	850	510	175	370	340	190	115	-0.04
9	880	660	220	390	360	200	125	-0.04
10	1000	700	185	425	390	200	125	-0.05
11	1025	680	200	445	400	220	125	-0.05
12	1065	730	210	460	415	230	125	-0.05
13	1100	705	195	470	420	240	130	-0.05
14	1065	725	200	470	420	235	125	-0.05
15	1010	700	180	465	400	230	125	-0.05
16	900	600	200	450	400	215	140	-0.03
17	865	655	205	440	400	205	140	-0.03
18	810	600	175	425	380	170	130	-0.03
19	775	570	170	410	370	165	125	-0.03
20	750	555	150	345	350	155	120	-0.03

# Temperature and Pressure Readings

SECOND FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	21	22U	22L	23U	23L	24U	24L	25	
1	95	90	90	95	95	95	95	95	0.03
2	100	90	90	100	100	100	95	95	0.02
3	100	95	90	95	95	95	90	90	0.02
4	115	100	90	100	100	100	95	95	0.02
5	145	115	95	105	105	105	95	100	-0.01
6	220	170	100	130	125	125	100	125	-0.01
7	330	260	160	185	175	170	120	160	-0.01
8	360	300	200	210	200	190	130	165	-0.02
9	370	315	215	240	225	210	145	170	-0.03
10	405	335	235	265	250	230	155	170	-0.03
11	425	355	250	285	265	245	165	175	-0.03
12	425	360	265	290	275	250	170	190	-0.03
13	420	365	275	305	285	260	180	195	-0.03
14	420	360	280	300	290	265	180	185	-0.03
15	400	350	290	300	290	260	180	180	-0.03
16	385	335	260	295	280	255	180	180	-0.03
17	375	325	265	290	275	255	185	185	-0.03
18	360	320	255	285	275	250	180	180	-0.03
19	350	310	245	275	265	240	175	185	-0.03
20	340	300	235	265	260	230	170	170	-0.02

THIRD FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	31	32U	32L	33U	33L	34U	34L	35	
1	90	90	95	95	95	95	95	95	0.00
2	90	90	95	95	95	95	95	95	0.01
3	90	90	95	95	95	95	95	95	0.01
4	100	95	95	95	95	95	95	95	0.00
5	105	100	100	100	100	100	100	100	-0.02
6	140	115	110	105	100	100	100	105	-0.03
7	210	160	130	130	105	120	110	125	-0.03
8	230	190	145	145	110	125	120	135	-0.02
9	245	205	160	160	120	140	130	145	-0.03
10	260	220	175	175	135	150	145	155	-0.03
11	280	235	195	190	145	165	155	160	-0.03
12	285	250	210	200	155	180	165	175	-0.03
13	285	250	215	210	160	185	165	175	-0.03
14	285	250	215	210	165	185	170	175	-0.03
15	275	250	210	210	165	185	170	180	-0.03
16	260	240	210	205	165	180	165	175	-0.02
17	260	235	200	200	160	175	165	175	-0.02
18	250	235	200	200	160	175	165	175	-0.02
19	255	230	200	200	160	175	165	170	-0.03
20	245	230	200	200	175	180	175	175	-0.03

## **Series G**

### **Vents and Curtain Boards — Classroom Fires**

This series is a study of the effectiveness of vents and curtain boards when fires originate in a classroom and transoms between the room and the corridor are open.

#### **Test G-1**

**Date:** May 8, 1959

**Outdoor Temperature:** 71° F   **Humidity:** 64%   **Wind:** 6.2  
m p h   W Average

**Fuel:** 1,400 pounds of pallets

**Location of Test Fire:** Classroom No 204

**Automatic Sprinklers:** None

**Vents:** 42 square feet at top of stairway No 1

**Curtain Boards:** Corridors only

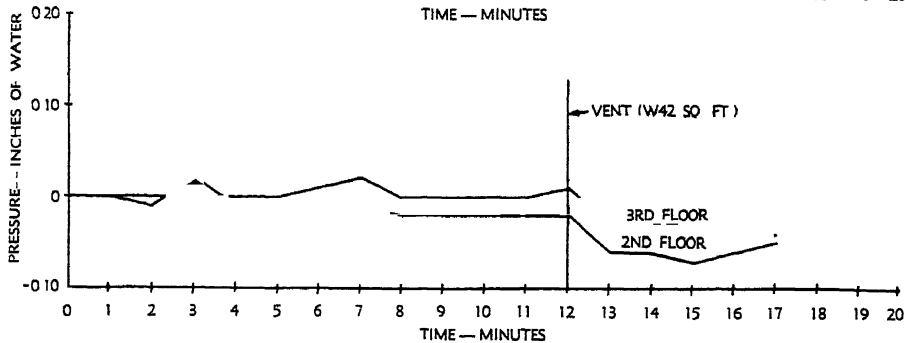
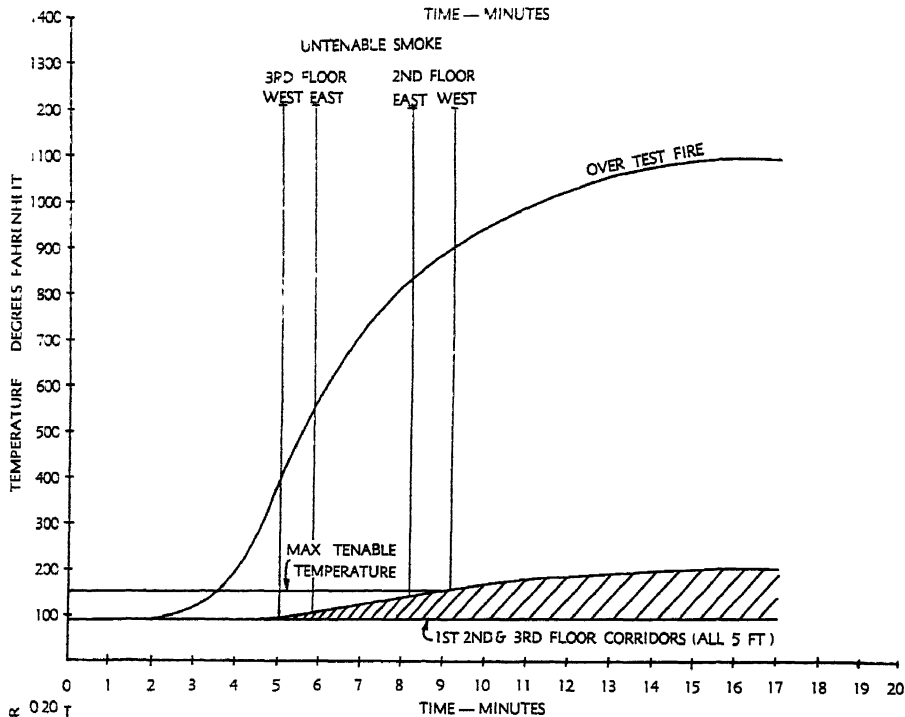
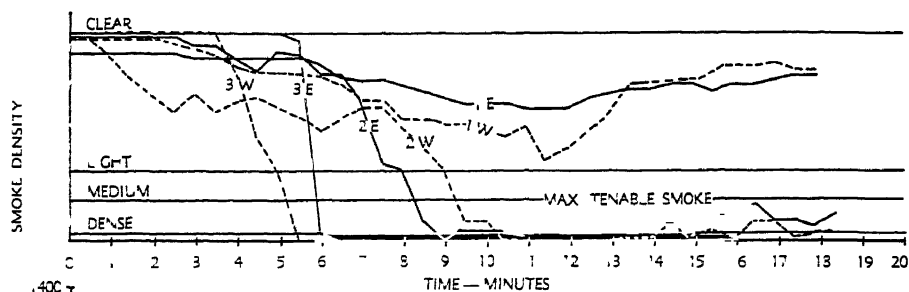
**Automatic Fire Detection:** None

**Other:** Vent opened at operation of fusible link rated at 165 degrees Fahrenheit   Two exterior windows in classroom 204 open 1 foot from the bottom. Two transoms between classroom and corridor open. No pressure readings taken in the first floor corridor.

#### **Comments:**

Vent (opened in 12 minutes) did not clear smoke from second or third floor corridors.

Untenable smoke conditions in this fire were reached quicker than in comparable base Test A-3 with no curtain boards or vents.



## Temperature and Pressure Readings

FIRST FLOOR								
Time Minutes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	1*	12U	12L	13U	13L	14U	14L	
1	90	95	85	100	90	95	85	
2	95	95	85	100	90	95	85	
3	115	95	85	100	90	95	85	
4	195	95	35	100	90	95	85	
5	390	95	85	100	95	100	85	
6	590	95	85	100	95	95	85	
7	775	95	85	100	100	100	85	
8	785	95	85	100	100	100	85	
9	845	95	85	100	100	100	85	
10	905	95	85	100	100	100	85	
11	1050	95	85	100	100	100	85	
12	1065	95	85	100	100	100	85	
13	1095	95	85	100	100	95	85	
14	985	95	85	100	100	100	85	
15	1085	90	85	100	100	95	85	
16	1100	90	90	95	100	100	85	
17	1105	90	85	95	100	100	85	
18								
19								
20								

\*Classroom 204

[illegible]



**Test G-2**

**Date:** May 8, 1959

**Outdoor Temperature:** 69° F. **Humidity:** 64% **Wind:** 6.2  
m p h W Average

**Fuel:** 1,400 pounds of pallets

**Location of Test Fire:** Classroom No. 204

**Automatic Sprinklers:** None

**Vents:** 42 square feet at top of stairway No. 2; 42 square feet at  
top of stairway No. 1

**Curtain Boards:** Corridors only

**Automatic Fire Detection:** None

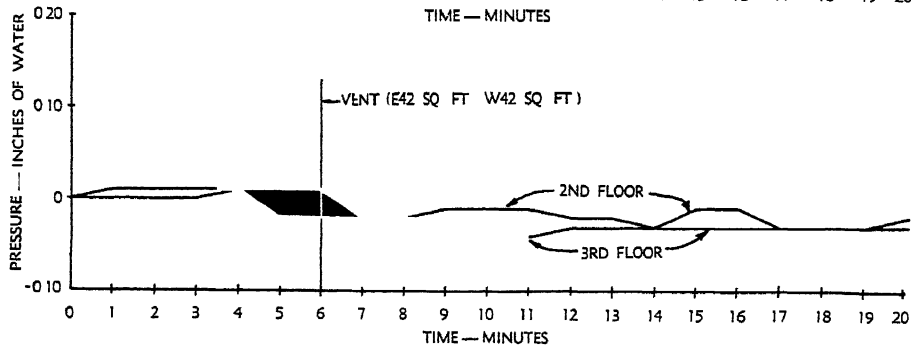
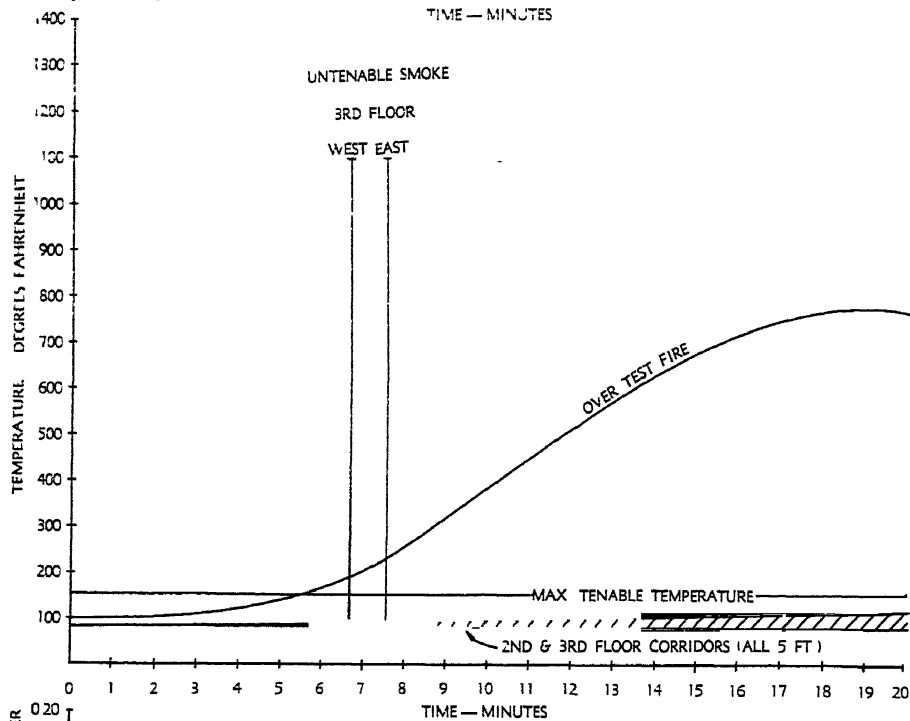
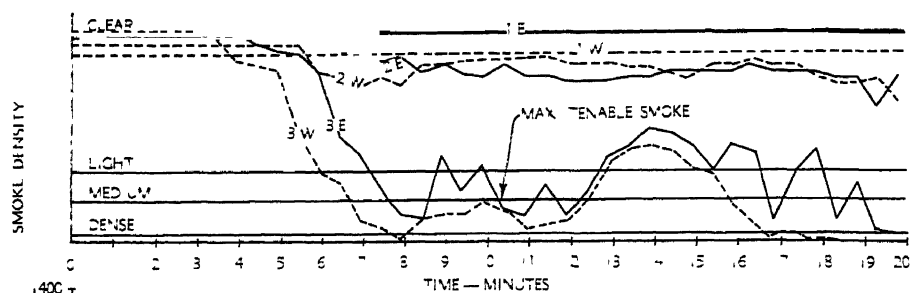
**Other:** Vents opened when temperature at thermocouple nearest  
test fire reached 165 degrees Fahrenheit. Two windows in  
classroom No. 204 open one foot from the bottom and two  
transoms between the classroom and the corridor open.  
No pressure readings taken in first floor corridor.

**Comments:**

Second floor corridor remained tenable from smoke during the entire test.

Test fire developed very slowly and attained a maximum temperature in classroom No. 204 of 795 degrees Fahrenheit.

Maximum tenable temperature (150° F.) never reached at the 5 foot level in any of the corridors.



### Temperature and Pressure Readings

FIRST FLOOR								
Time Minutes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11 *	12U	12L	13U	13L	14U	14L	
1	100	85	85	85	85	85	80	
2	110	85	85	85	85	85	80	
3	115	85	85	85	85	85	80	
4	125	85	85	85	85	85	80	
5	135	85	85	90	90	90	80	
6	160	85	85	90	90	90	80	
7	195	85	85	90	90	90	80	
8	255	85	85	90	90	90	80	
9	335	85	85	85	85	85	80	
10	385	85	85	85	85	85	80	
11	450	85	85	85	85	85	80	
12	490	85	85	85	85	85	80	
13	555	85	85	85	85	85	80	
14	610	80	80	85	85	85	80	
15	685	80	80	85	85	85	80	
16	720	85	85	85	85	85	80	
17	755	85	85	85	85	85	80	
18	755	85	85	85	85	85	80	
19	755	85	80	85	85	85	80	
20	770	85	80	85	85	85	80	

\*Classroom 204

SECOND FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	21	22U	22L	23U	23L	24U	24L	25	
1	90	85	85	95	90	105	95	90	0.01
2	90	85	85	95	95	105	90	90	0.01
3	90	85	85	95	90	105	90	90	0.01
4	90	85	85	95	95	105	90	90	0.01
5	90	85	85	95	90	110	90	90	0.01
6	90	85	85	95	90	115	95	90	0.01
7	90	85	85	105	95	135	95	90	-0.02
8	90	85	85	105	90	160	95	90	-0.02
9	90	90	85	105	95	180	95	90	-0.01
10	90	90	85	105	95	205	95	85	-0.01
11	90	90	85	105	95	240	90	85	-0.01
12	85	95	85	110	95	265	95	85	-0.02
13	90	100	85	120	95	305	95	85	-0.02
14	85	100	85	125	95	355	95	85	-0.03
15	90	105	85	120	95	330	100	85	-0.01
16	85	100	85	130	95	345	100	85	-0.01
17	85	105	85	130	100	365	100	85	-0.03
18	85	105	85	140	100	365	100	85	-0.03
19	90	120	85	145	100	410	100	85	-0.03
20	85	120	85	140	100	435	105	85	-0.02

## Temperature and Pressure Readings

THIRD FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	31	32U	32L	33U	33L	34U	34L	35	
1	85	85	90	90	90	90	90	90	0.00
2	85	85	90	95	95	95	95	95	0.00
3	85	85	90	95	95	95	95	95	0.00
4	85	85	95	95	95	95	95	95	0.01
5	85	85	95	95	95	95	95	100	-0.02
6	85	85	95	95	95	95	95	100	-0.02
7	85	85	95	95	95	100	95	100	-0.02
8	85	85	95	105	100	100	100	105	-0.02
9	90	90	95	105	100	110	100	105	-0.03
10	85	90	95	110	100	115	100	105	-0.04
11	85	90	95	110	100	120	100	110	-0.04
12	85	95	95	115	105	130	105	115	-0.03
13	90	100	95	105	100	140	105	125	-0.03
14	90	95	95	110	100	140	105	130	-0.03
15	90	95	95	115	100	145	105	125	-0.03
16	90	100	95	125	100	145	105	125	-0.03
17	90	105	95	130	110	155	110	135	-0.03
18	90	110	95	140	115	170	115	140	-0.03
19	90	120	100	150	125	175	125	150	-0.03
20	95	125	100	150	125	190	120	150	-0.03

### Test G-3

**Date:** May 27, 1959

**Outdoor Temperature:** 71° F. **Humidity:** 53% **Wind:** 5.8 m.p.h. W Average

**Fuel:** 1,400 pounds of pallets

**Location of Test Fire:** Classroom No. 104

**Automatic Sprinklers:** None

**Vents:** 42 square feet at top of stairway No. 2; 42 square feet at top of stairway No. 1

**Curtain Boards:** Only at stairway openings to corridors

**Automatic Fire Detection:** None

**Other:** Vents opened at operation of fusible links rated at 160 degrees Fahrenheit. Both stairways opened to provide clear passage to the top. Two windows in classroom No. 104 open one foot from the bottom and two transoms between the classroom and the corridor open.

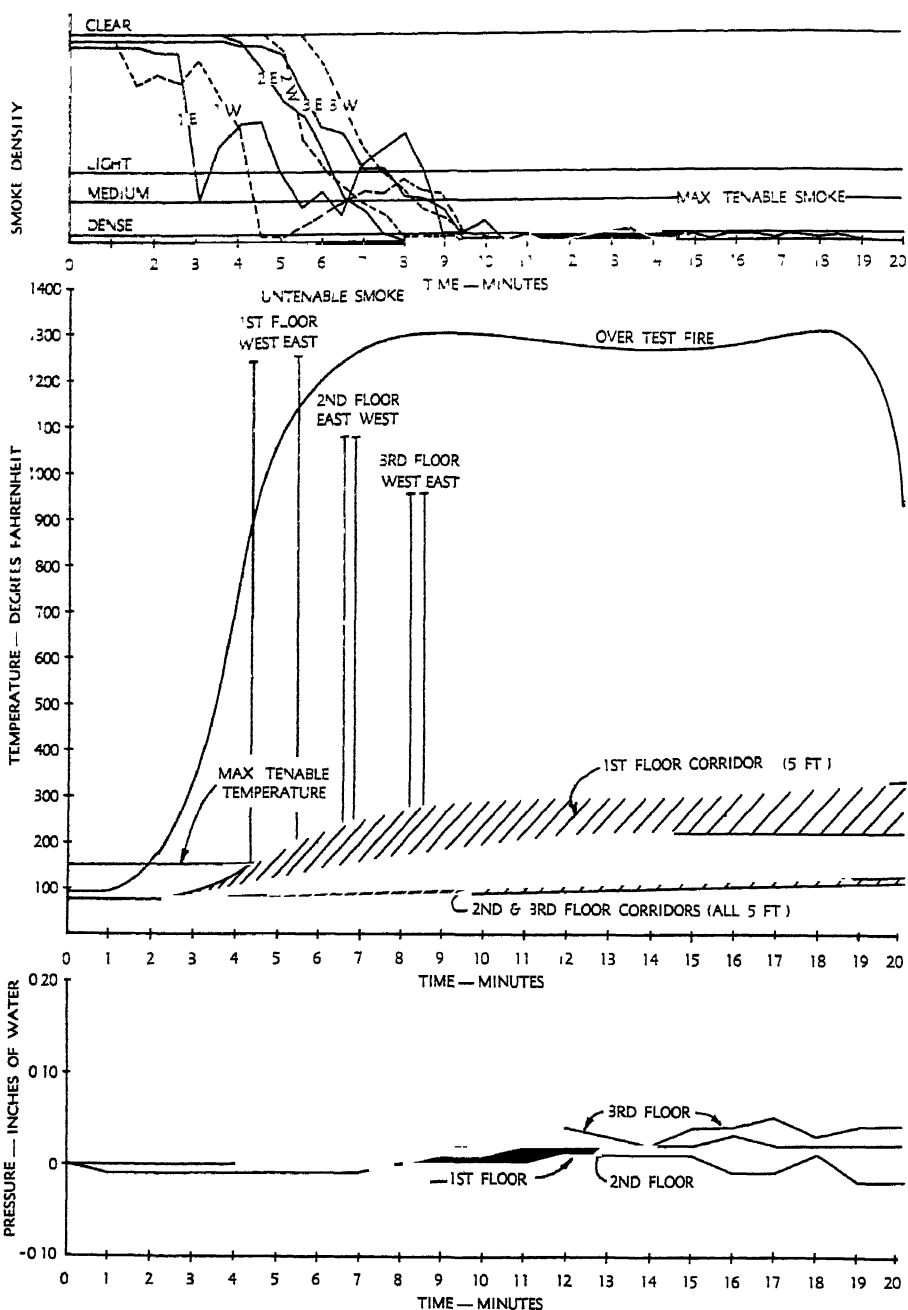
**Comments:**

Very smoky and fast developing test fire.

Fusible links did not operate due to insufficient temperature rise.

Curtain boards had no apparent effect on smoke distribution.

Smoke conditions worse than encountered in other tests G-1 and G-2 of this series.



## Temperature and Pressure Readings

FIRST FLOOR								
Time Minutes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11 *	12U	12L	13U	13L	14U	14L	
1	90	75	75	75	75	75	75	-0.01
2	140	80	75	80	80	85	80	-0.01
3	315	115	90	115	80	120	80	-0.01
4	625	195	115	190	110	215	105	-0.01
5	1265	320	180	340	185	370	185	-0.01
6	1315	355	200	400	235	435	210	-0.01
7	1235	355	160	415	240	445	180	-0.01
8	1235	350	145	405	220	425	140	0.00
9	1395	405	230	485	280	500	290	0.00
10	1395	420	275	500	295	520	295	0.00
11	1300	415	205	495	290	525	270	0.00
12	1290	400	215	490	280	520	250	0.01
13	1240	390	180	485	285	515	235	0.01
14	1285	410	230	495	285	525	295	0.01
15	1295	445	280	540	320	520	320	0.01
16	1145	415	215	505	295	550	235	-0.01
17	1210	440	215	530	300	555	290	-0.01
18	1290	475	230	555	305	550	275	0.01
19	1360	500	275	670	335	590	345	-0.01
20	935	500	320	610	360	610	375	-0.01

\*Classroom 104

SECOND FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	21	22U	22L	23U	23L	24U	24L	25	
1	75	75	75	75	75	75	75	75	0.00
2	75	75	80	75	75	75	75	75	0.00
3	75	75	75	75	75	75	75	75	0.00
4	80	75	75	75	75	75	75	75	0.00
5	95	80	75	80	75	85	80	105	0.00
6	110	90	80	90	85	95	85	120	0.00
7	115	90	85	95	90	100	85	125	0.00
8	110	90	90	95	90	100	90	115	0.00
9	125	100	90	95	95	110	95	145	0.01
10	140	105	95	110	100	115	100	150	0.01
11	150	110	100	110	110	120	105	155	0.02
12	145	115	105	115	110	120	105	155	0.02
13	145	115	105	115	110	125	110	155	0.02
14	145	115	110	115	110	125	110	155	0.02
15	155	120	110	115	115	130	115	170	0.02
16	155	120	115	120	115	130	110	170	0.03
17	155	120	115	120	120	130	115	165	0.02
18	155	120	115	120	115	130	115	165	0.02
19	165	130	115	120	120	130	115	170	0.02
20	180	130	120	125	120	135	120	180	0.02

### Temperature and Pressure Readings

THIRD FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	31	32U	32L	33U	33L	34U	34L	35	
1	75	75	75	75	75	75	75	75	0.00
2	75	75	75	75	75	75	75	75	0.00
3	75	75	75	75	75	75	75	75	0.00
4	75	75	75	75	75	75	75	75	0.00
5	85	75	80	75	75	75	75	85	0.01
6	95	80	80	80	80	80	80	90	0.02
7	95	85	80	80	80	90	80	100	0.02
8	95	85	85	85	85	90	85	100	0.02
9	105	85	85	85	85	95	85	105	0.02
10	110	95	90	90	90	100	90	110	0.02
11	100	100	95	100	95	105	95	125	0.03
12	115	100	95	100	100	105	100	120	0.04
13	115	105	100	100	100	110	100	120	0.03
14	120	105	105	105	105	110	105	125	0.02
15	125	110	105	105	105	110	105	125	0.04
16	125	115	110	105	105	110	105	130	0.04
17	125	115	110	105	105	115	105	130	0.05
18	125	115	110	105	110	115	105	130	0.03
19	135	115	115	110	110	115	110	125	0.04
20	140	120	110	115	110	115	110	135	0.04

**Test G-4**

**Date:** May 27, 1959

**Outdoor Temperature:** 69° F   **Humidity:** 53%   **Wind:** 5.8  
m p h   W Average

**Fuel:** 1,400 pounds of pallets

**Location of Test Fire:** Classroom No 104

**Automatic Sprinklers:** None

**Vents:** 42 square feet at top of stairway No. 2; 42 square feet at  
top of stairway No 1

**Curtain Boards:** Only at stairway openings to corridors

**Automatic Fire Detection:** None

**Other:** Vents opened when temperature at thermocouple nearest  
test fire reached 200 degrees Fahrenheit Both stairways  
opened to provide unobstructed passage to the top. Two  
windows in classroom No. 104 open one foot from the bot-  
tom and two transoms between the classroom and the cor-  
ridor open.

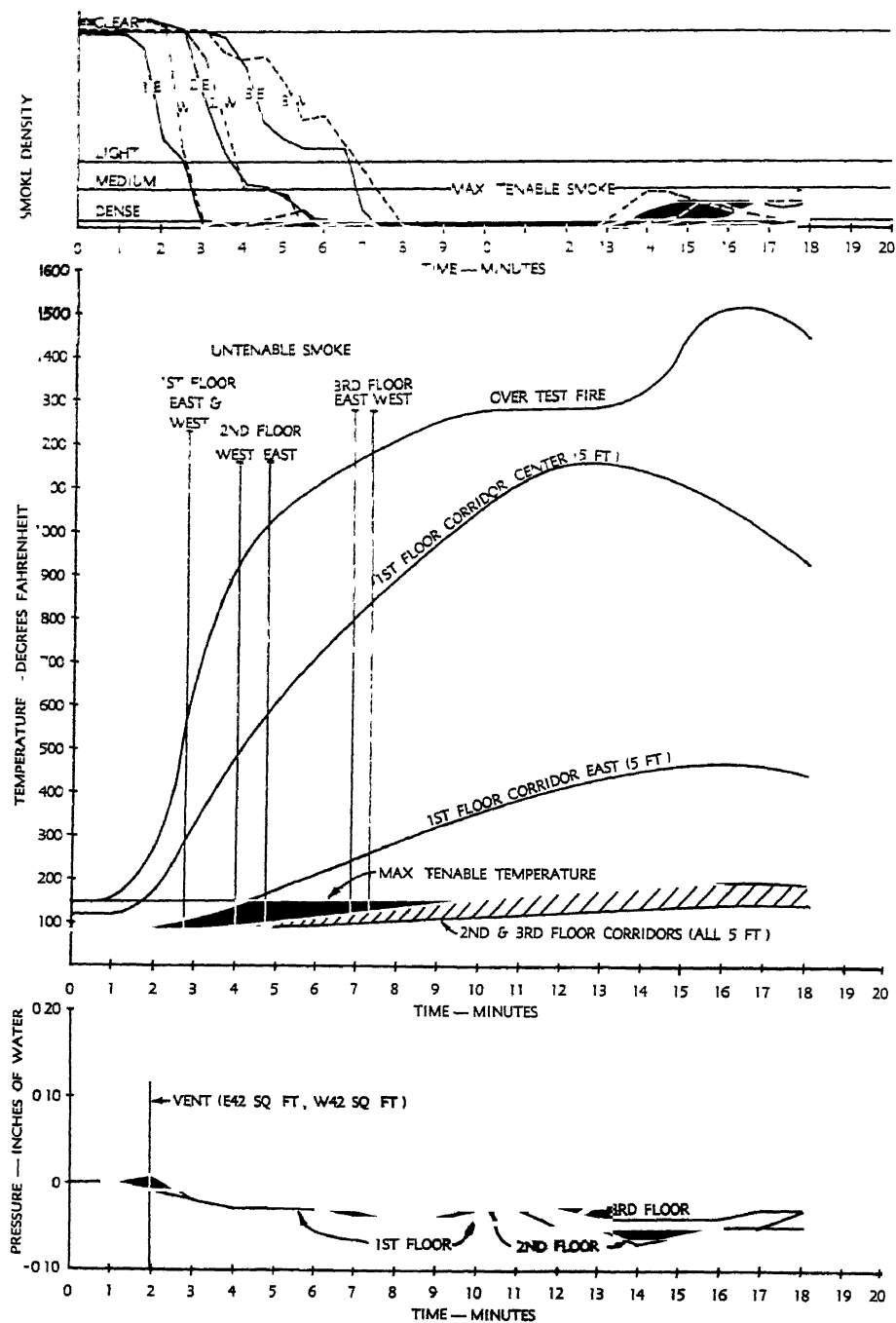
**Comments:**

Rapid development of test fire.

Untenable smoke conditions in all corridors reached  
relatively quickly.

Curtain boards at stairway openings interfered with  
vent action

Maximum tenable temperature reached in first floor  
corridor in 3 to 4 minutes at the 5 foot level.



## Temperature and Pressure Readings

FIRST FLOOR								
Time Minutes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11*	12U	12L	13U	13L	14U	14L	
1	145	100	80	110	120	95	85	0.00
2	260	130	95	140	160	110	85	-0.01
3	700	255	115	275	345	170	130	-0.01
4	940	390	165	430	515	305	185	-0.02
5	1025	435	170	500	600	350	185	-0.03
6	1125	455	175	565	710	390	205	-0.03
7	1125	495	220	565	710	390	245	-0.03
8	1225	585	300	610	845	440	345	-0.04
9	1265	570	280	655	950	490	365	-0.04
10	1245	580	255	685	940	490	350	-0.04
11	1280	605	295	710	1095	495	410	-0.05
12	1260	655	395	775	1295	565	620	-0.05
13	1290	695	445	830	1215	620	695	-0.05
14	1280	680	430	800	1110	620	650	-0.05
15	1290	695	455	790	1080	635	680	-0.05
16	1550	695	420	800	1015	640	610	-0.05
17	1475	735	490	825	1000	665	705	-0.05
18	1450	650	460	795	930	695	485	-0.03
19								
20								

\*Classroom 104

[illegible]



## Series H

### Vents and Curtain Boards — Corridor Fires

This series like series E, F, and G was conducted to determine the effectiveness of curtain boards and vents but the test fires were all built in the first floor corridor. The test fires were all in 700 pounds of pallets rather than the usual 1,400 pounds.

#### Test H-1

**Date:** May 22, 1959

**Outdoor Temperature:** 63° F. **Humidity:** 61% **Wind:** 8.6 m p h. S Average

**Fuel:** 700 pounds of pallets

**Location of Test Fire:** First floor corridor just east of the curtain board

**Automatic Sprinklers:** None

**Vents:** 42 square feet at top of stairway No. 2; 42 square feet at top of stairway No. 1

**Curtain Boards:** Corridors and in the stairway openings to corridors

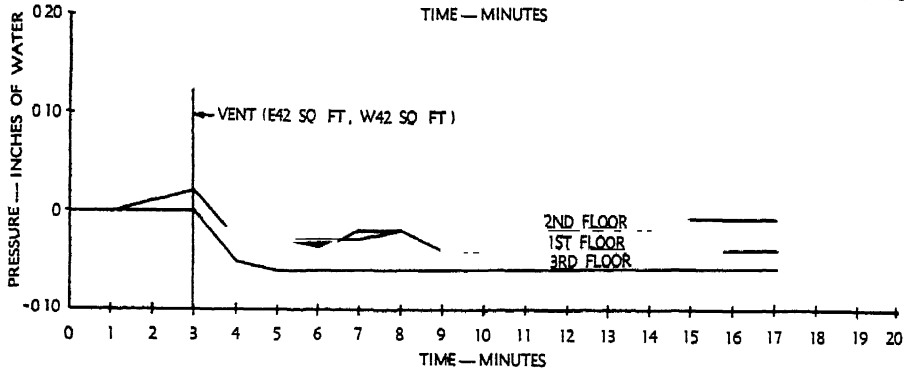
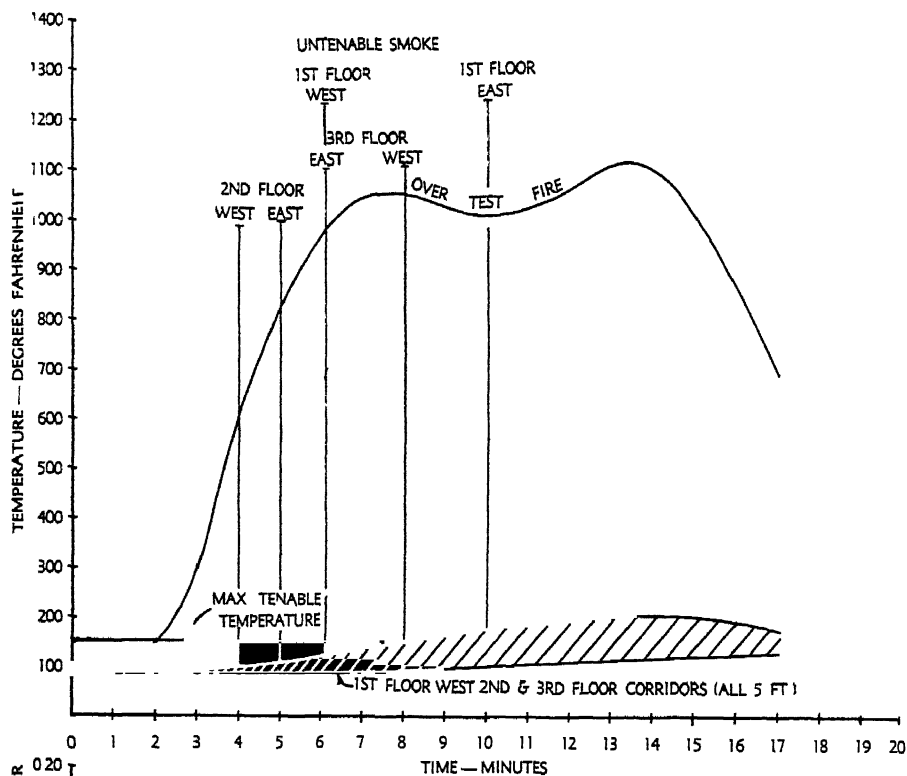
**Automatic Fire Detection:** None

**Other:** Vents opened when temperature at thermocouple nearest test fire reached 200 degrees Fahrenheit. Exit doors at west end of first floor corridor opened 30 seconds after vents. Both stairways opened to provide unobstructed passage to the top. No smoke density readings taken during this test. Reports of smoke conditions from observers only.

#### Comments:

All corridors became untenable from smoke after vents were opened.

Curtain board in first floor corridor kept temperature at the 5 foot level at the west end of that corridor below the maximum tenable level. Curtain boards at stairway openings decreased effectiveness of vents.



## Temperature and Pressure Readings

FIRST FLOOR								
Time Minutes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11	12U	12L	13U	13L	14U	14L	
1	110	100	90	105	100	95	80	0.00
2	115	190	95	140	100	95	85	0.01
3	120	320	100	300	180	115	85	0.02
4	90	450	120	450	290	180	90	-0.03
5	95	535	140	600	305	215	85	-0.03
6	95	875	225	1015	585	320	85	-0.03
7	95	840	250	1070	615	365	90	-0.03
8	90	1010	260	1070	675	420	105	-0.02
9	90	950	295	1020	770	400	105	-0.04
10	90	960	265	1035	780	400	100	-0.04
11	90	1115	210	1020	840	430	115	-0.04
12	90	1000	480	1060	800	425	110	-0.04
13	90	935	445	1120	780	550	120	-0.04
14	90	830	340	1110	575	500	120	-0.04
15	90	740	315	975	465	480	125	-0.04
16	90	710	230	770	400	475	140	-0.04
17	90	600	125	700	430	470	285	-0.04
18								
19								
20								

[illegible]



## Test H-2

**Date:** May 28, 1959

**Outdoor Temperature:** 72° F. **Humidity:** 57% **Wind:** 6.8 m.p h. W Average

**Fuel:** 700 pounds of pallets

**Location of Test Fire:** First floor corridor just east of curtain board

**Automatic Sprinklers:** None

**Vents:** 42 square feet at top of stairway No. 2, 42 square feet at top of stairway No 1

**Curtain Boards:** Corridors only

**Automatic Fire Detection:** None

**Other:** Vents opened with operation of fusible links rated at 165 degrees Fahrenheit Both stairways opened to provide unobstructed passage to the top.

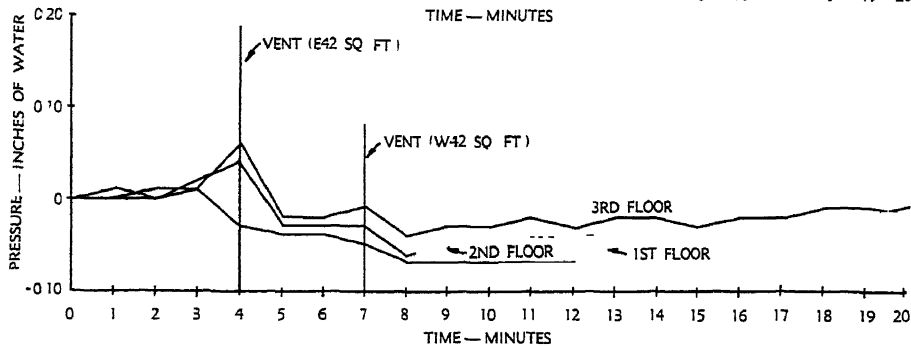
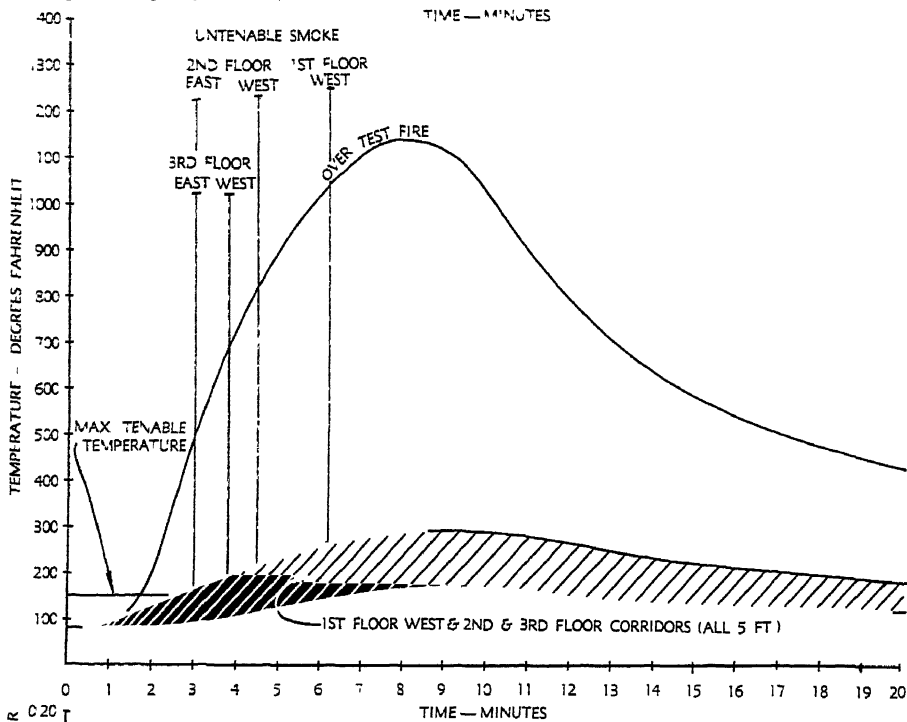
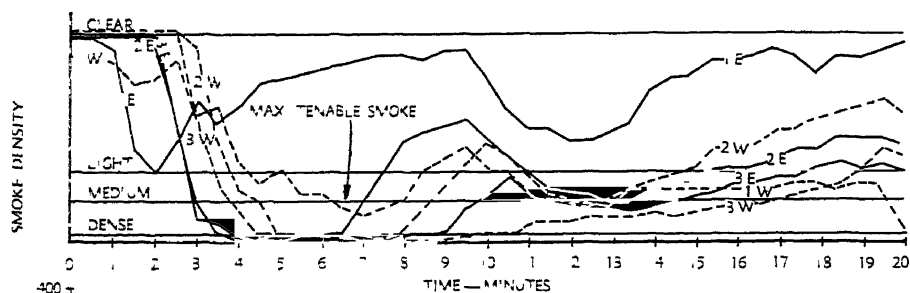
### Comments:

Test fire developed very fast.

Vents did start to clear the second floor about 3 minutes after the east vent was opened and the third floor corridor in 5 minutes

Maximum tenable temperature was reached quickly on all floors about the same time that smoke conditions became untenable

Vent over stairway No. 2 opened in 4 minutes; over stairway No. 1 in 7 minutes



## Temperature and Pressure Readings

FIRST FLOOR								
Time Min- utes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11	12U	12L	13U	13L	14U	14L	
1	95	85	75	85	85	85	75	0.00
2	85	145	90	145	100	90	80	0.01
3	100	470	205	610	195	110	85	0.01
4	105	650	300	805	380	175	100	-0.03
5	100	700	310	805	600	240	120	-0.04
6	95	770	465	890	810	350	150	-0.04
7	90	840	545	1175	920	430	190	-0.05
8	90	895	460	1195	1075	500	225	-0.07
9	90	835	510	1120	1010	440	235	-0.07
10	90	755	435	1050	795	360	230	-0.07
11	90	690	455	890	775	310	245	-0.07
12	90	585	400	815	720	290	215	-0.07
13	90	525	355	700	580	250	200	-0.05
14	90	485	290	650	525	225	185	-0.05
15	90	400	295	575	400	220	175	-0.05
16	90	435	290	555	395	200	160	-0.05
17	90	415	225	500	355	185	155	-0.05
18	90	395	215	470	350	190	145	-0.04
19	90	370	185	435	330	170	165	-0.03
20	90	370	185	435	310	170	115	-0.02

SECOND FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	21	22U	22L	23U	23L	24U	24L	25	
1	75	75	75	85	85	85	85	85	0.01
2	80	80	75	85	85	85	85	85	0.00
3	200	170	80	135	135	105	90	90	0.02
4	330	265	170	195	195	145	110	115	0.04
5	370	290	185	210	210	155	125	165	0.03
6	420	340	220	240	240	195	155	225	0.03
7	460	380	265	275	285	230	180	275	0.03
8	450	375	265	280	290	275	200	305	-0.06
9	445	380	260	285	295	260	215	270	-0.05
10	420	355	255	280	285	235	215	240	-0.04
11	385	320	240	260	260	225	205	230	-0.04
12	335	245	220	255	255	215	195	220	-0.04
13	310	260	205	235	240	195	185	200	-0.04
14	290	245	190	220	225	185	125	185	-0.04
15	275	230	185	210	210	175	165	175	-0.04
16	265	225	180	200	200	165	160	165	-0.03
17	245	210	175	190	190	155	155	160	-0.03
18	235	205	165	190	185	155	150	155	-0.02
19	215	195	165	180	175	150	140	135	-0.02
20	215	195	165	180	175	150	140	135	-0.01

### Temperature and Pressure Readings

THIRD FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	31	32U	32L	33U	33L	34U	34L	35	
1	75	75	85	85	85	85	85	85	0.00
2	80	80	85	85	85	85	85	85	0.00
3	120	115	130	105	85	110	100	90	0.01
4	200	185	180	145	150	145	130	125	0.06
5	175	185	170	145	150	145	135	150	-0.02
6	170	195	155	145	145	160	140	180	-0.02
7	185	210	160	160	150	180	165	215	-0.01
8	200	225	170	165	160	185	165	220	-0.04
9	215	235	185	175	160	185	165	215	-0.03
10	210	240	190	180	165	180	165	200	-0.03
11	205	230	195	180	160	175	160	190	-0.02
12	195	215	185	175	160	170	160	185	-0.03
13	180	200	180	175	155	165	160	175	-0.02
14	175	190	170	165	150	155	150	170	-0.02
15	170	185	165	160	145	150	150	160	-0.03
16	165	175	160	160	140	145	145	155	-0.02
17	165	170	155	150	135	140	140	150	-0.02
18	155	165	150	145	130	130	130	145	-0.01
19	150	160	145	140	130	135	130	135	-0.01
20	150	160	145	140	130	135	130	135	-0.02

**Test H-3**

**Date:** May 28, 1959

**Outdoor Temperature:** 70° F. **Humidity:** 57% **Wind:** 6.8  
m p.h. W Average

**Fuel:** 700 pounds of pallets

**Location of Test Fire:** First floor corridor just east of curtain  
board

**Automatic Sprinklers:** None

**Vents:** 42 square feet in stairway No. 2; 42 square feet in  
stairway No. 1

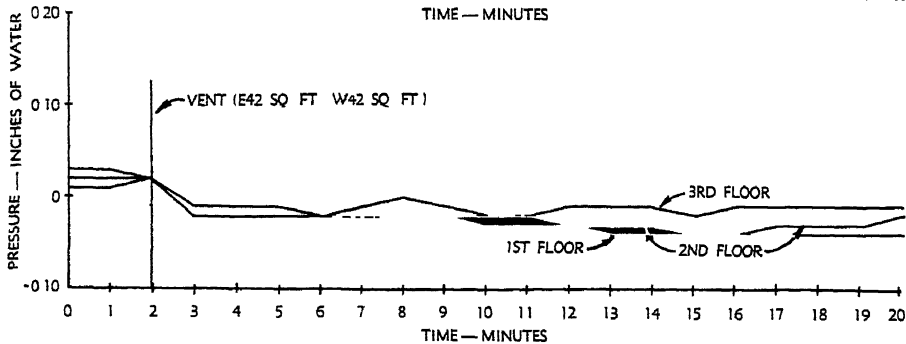
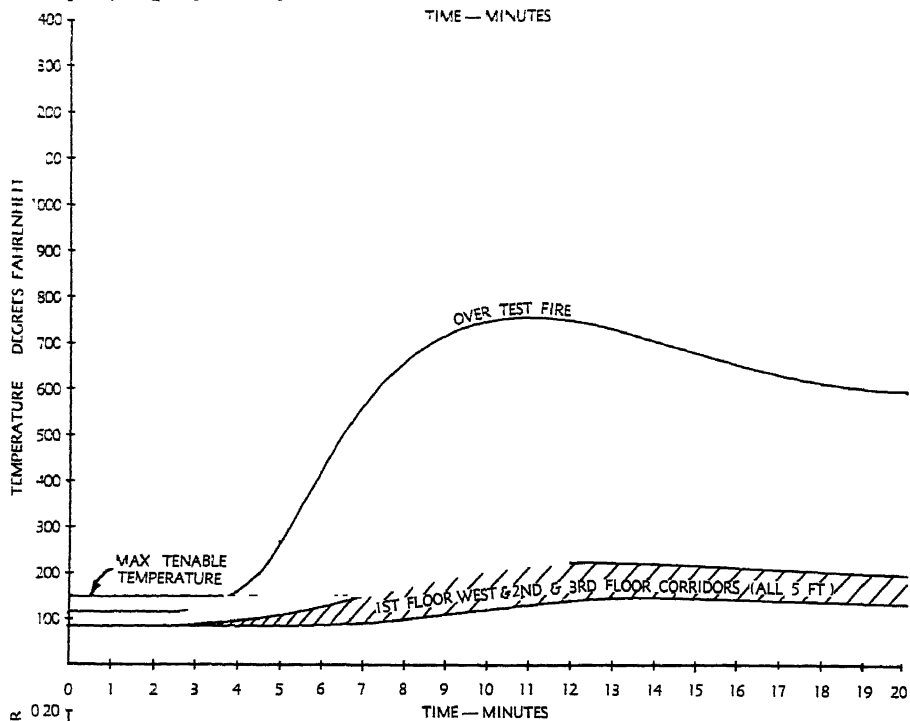
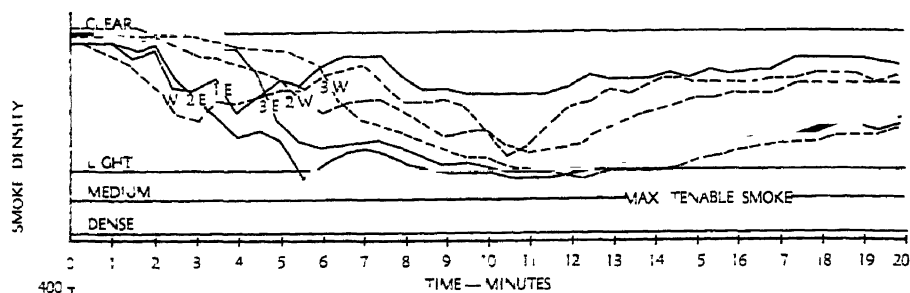
**Curtain Boards:** Corridors only

**Automatic Fire Detection:** None

**Other:** Vents opened 2 minutes after start of test fire. Both  
stairways opened to provide unobstructed passage to top.

**Comments:**

The reason for the lack of untenable smoke conditions is  
unexplainable. A rerun of this test (Test H-4) produced results  
typical of conditions that existed in other similar tests



## Temperature and Pressure Readings

FIRST FLOOR								
Time Min- utes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11	12U	12L	13U	13L	14U	14L	
1	85	110	85	110	95	90	35	0.02
2	85	110	85	110	95	95	85	0.02
3	85	115	85	115	100	95	85	-0.02
4	85	160	85	145	110	95	85	-0.02
5	85	265	85	265	130	100	55	-0.02
6	85	400	95	415	160	105	95	-0.02
7	85	450	110	565	270	120	105	-0.02
8	85	515	125	675	415	145	125	-0.02
9	85	540	135	700	435	170	130	-0.02
10	85	575	140	715	475	175	135	-0.02
11	85	585	150	760	500	130	145	-0.02
12	85	525	150	755	470	130	145	-0.03
13	85	540	150	700	460	180	140	-0.04
14	85	540	140	690	480	195	145	-0.04
15	85	520	150	660	490	180	140	-0.04
16	85	490	150	640	445	180	140	-0.04
17	85	475	145	610	490	170	140	-0.04
18	85	475	140	605	450	170	135	-0.04
19	85	455	140	595	445	165	140	-0.04
20	85	465	140	590	425	180	130	-0.04

SECOND FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	21	22U	22L	23U	23L	24U	24L	25	
1	95	90	85	90	90	90	90	90	0.01
2	95	90	85	95	90	90	90	90	0.02
3	95	90	85	95	90	90	90	90	-0.01
4	95	90	85	95	95	90	90	90	-0.01
5	130	120	90	100	100	90	90	90	-0.01
6	190	160	110	120	120	100	95	95	-0.02
7	240	190	125	145	145	110	100	105	-0.02
8	295	220	145	180	170	130	110	125	-0.02
9	320	240	165	195	190	140	125	135	-0.02
10	320	250	175	200	200	150	130	140	-0.03
11	340	260	130	210	205	150	140	140	-0.03
12	350	260	180	215	215	160	140	145	-0.03
13	335	260	185	215	215	165	145	145	-0.03
14	330	250	185	215	215	165	150	150	-0.03
15	310	245	190	220	220	170	150	150	-0.04
16	305	235	180	210	210	165	145	145	-0.04
17	295	230	185	205	205	155	145	145	-0.03
18	290	225	175	200	205	155	145	145	-0.03
19	285	225	170	200	200	150	140	140	-0.03
20	285	225	170	195	195	150	140	140	-0.02

### Temperature and Pressure Readings

THIRD FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	31	32U	32L	33U	33L	34U	34L	35	
1	85	90	90	90	90	90	90	90	0.03
2	85	85	90	90	90	90	90	90	0.02
3	85	85	90	90	90	90	90	90	-0.01
4	85	85	90	90	90	90	90	90	-0.01
5	90	90	90	90	90	90	90	90	-0.01
6	110	110	90	90	95	90	90	95	-0.02
7	125	125	105	110	90	100	90	100	-0.01
8	150	150	125	120	100	110	105	110	0.00
9	170	170	140	135	110	125	115	120	-0.01
10	185	185	145	140	115	130	120	125	-0.02
11	185	195	160	150	130	140	130	130	-0.02
12	185	200	165	160	135	145	135	135	-0.01
13	195	200	175	165	135	150	140	135	-0.01
14	190	200	175	165	140	150	140	140	-0.01
15	185	195	175	165	140	155	140	140	-0.02
16	175	190	170	160	140	150	140	135	-0.01
17	170	185	160	160	135	145	135	135	-0.01
18	175	180	160	160	135	145	135	135	-0.01
19	170	175	160	155	135	145	135	135	-0.01
20	170	180	160	155	135	155	135	135	-0.01

**Test H-4**

**Date:** May 28, 1959

**Outdoor Temperature:** 70° F   **Humidity:** 57%   **Wind:** 6.8 m p h. W Average

**Fuel:** 700 pounds of pallets

**Location of Test Fire:** First floor corridor just east of curtain board location

**Automatic Sprinklers:** None

**Vents:** 42 square feet at top of stairway No. 2. 42 square feet at top of stairway No. 1

**Curtain Boards:** None

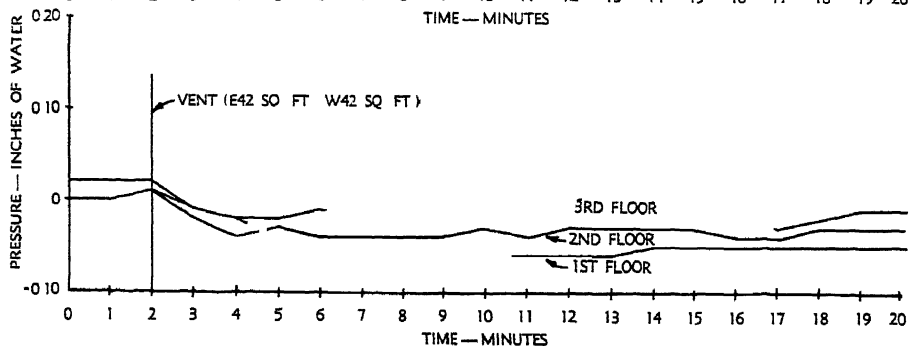
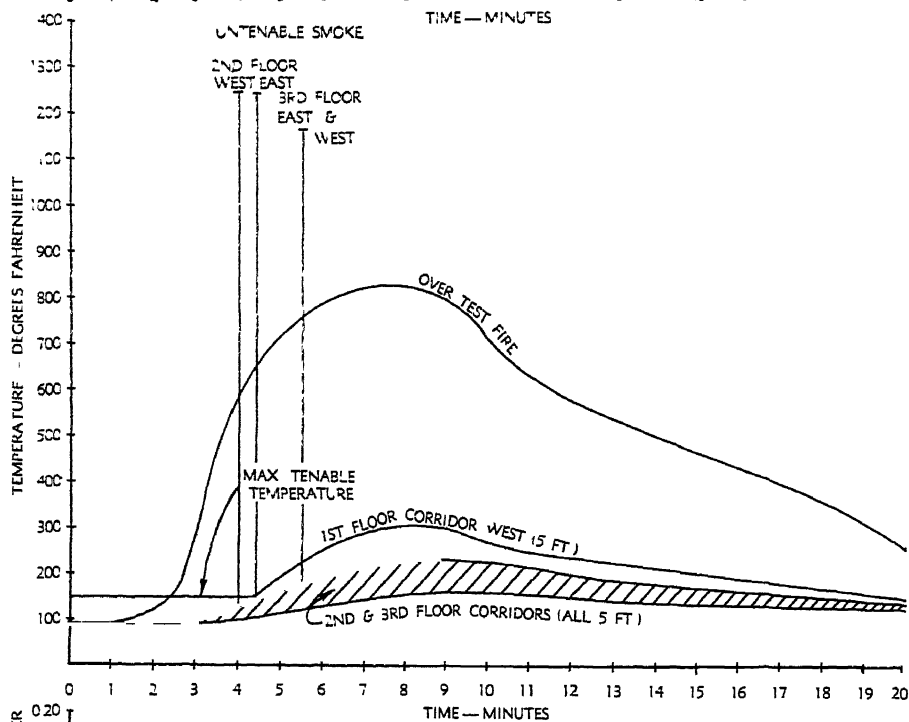
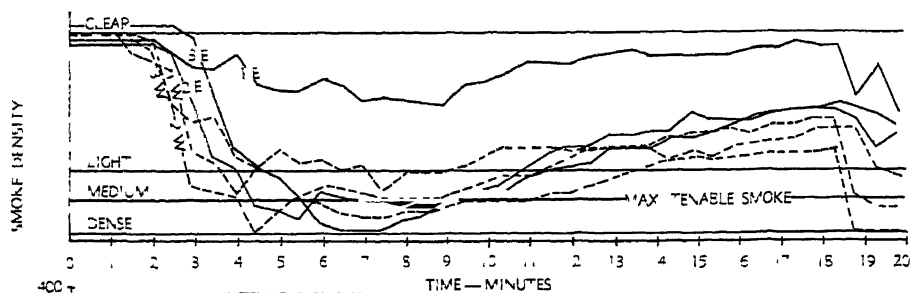
**Automatic Fire Detection:** None

**Other:** Vents opened 2 minutes after start of test fire. Both stairways opened to provide unobstructed passage to top. Thermocouple No. 11 not used in this test

**Comments:**

Vents started to clear smoke from third floor corridor 5 minutes after they were opened

Maximum tenable temperature reached in the second floor corridor in 4 to 5 minutes; third floor corridor in 7 to 8 minutes



## Temperature and Pressure Readings

FIRST FLOOR								
Time Min- utes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11	12U	12L	13U	13L	14U	14L	
1		105	30	105	95	95	80	0.00
2		120	80	115	95	100	80	0.01
3		350	190	285	125	240	105	-0.01
4		480	110	590	205	410	120	-0.02
5		615	160	785	410	555	195	-0.04
6		615	205	780	450	535	280	-0.05
7		660	220	800	670	485	300	-0.05
8		645	230	835	775	450	300	-0.05
9		620	230	820	765	440	305	-0.05
10		580	220	695	660	375	260	-0.06
11		500	180	615	570	360	240	-0.06
12		470	185	575	525	315	230	-0.06
13		440	170	535	480	290	225	-0.06
14		430	165	495	450	270	215	-0.05
15		405	160	485	445	260	205	-0.05
16		390	150	435	315	245	200	-0.05
17		360	145	415	270	240	180	-0.05
18		340	140	375	250	230	165	-0.05
19		290	140	265	170	135	135	-0.05
20		290	140	265	170	185	135	-0.05

SECOND FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	21	22U	22L	23U	23L	24U	24L	25	
1	95	85	85	95	95	90	90	90	0.00
2	95	80	80	95	95	90	90	95	0.01
3	130	115	90	100	100	125	95	125	-0.02
4	215	170	110	140	135	215	120	170	-0.04
5	295	220	160	210	185	300	175	320	-0.03
6	330	265	205	225	210	285	215	305	-0.04
7	355	270	210	225	225	275	225	280	-0.04
8	360	280	210	230	230	280	230	290	-0.04
9	335	275	215	230	230	275	235	275	-0.04
10	330	260	205	210	215	240	220	245	-0.03
11	295	220	190	200	200	230	205	230	-0.04
12	280	215	130	190	185	215	195	225	-0.03
13	265	205	175	185	185	205	190	210	-0.03
14	260	205	170	175	180	200	185	210	-0.03
15	245	185	160	175	170	195	175	200	-0.03
16	235	185	155	165	155	185	160	190	-0.04
17	220	175	150	160	160	175	160	180	-0.04
18	210	170	150	160	160	170	155	170	-0.03
19	200	155	145	155	150	145	145	145	-0.03
20	200	155	145	155	150	145	145	145	-0.03

## Temperature and Pressure Readings

THIRD FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	31	32U	32L	33U	33L	34U	34L	35	
1	85	85	90	90	90	90	90	90	0.02
2	80	80	90	90	90	90	90	90	0.02
3	85	95	90	95	90	100	90	125	-0.01
4	100	105	100	110	95	130	100	165	-0.02
5	125	130	115	130	110	165	115	210	-0.02
6	170	165	135	150	135	130	135	215	-0.01
7	180	185	145	160	145	190	150	225	-0.02
8	130	190	155	165	155	200	130	230	-0.02
9	180	190	155	170	155	195	160	225	-0.02
10	185	190	160	170	185	185	160	210	-0.02
11	180	185	155	165	155	180	155	200	-0.02
12	170	175	150	165	150	170	150	185	-0.02
13	160	165	145	155	145	165	145	180	-0.02
14	165	165	145	150	145	165	145	175	-0.02
15	155	155	140	145	140	160	140	175	-0.02
16	150	155	140	145	135	155	140	165	-0.02
17	140	150	135	140	135	150	135	160	-0.03
18	135	140	130	135	130	145	130	150	-0.02
19	135	140	130	155	130	140	130	140	-0.01
20	135	140	130	135	130	140	130	140	-0.01

## Series I

### Curtain Boards and Forced Draft Vent

Three tests were run to determine the effect of the venting action with an aspirator installed at the vent above stairway No 2 and curtain boards in corridors. This series includes those three tests.

#### Test I-1

**Date:** April 29, 1959

**Outdoor Temperature:** 82° F. **Humidity:** 33% **Wind:** 5.5 m.p.h. W Average

**Fuel:** 1,400 pounds of pallets

**Location of Test Fire:** Base of stairway No. 2

**Automatic Sprinklers:** None

**Vents:** 40 square feet at top of stairway No. 2

**Curtain Boards:** Corridors only

**Automatic Fire Detection:** Coverage as shown in Figure 12

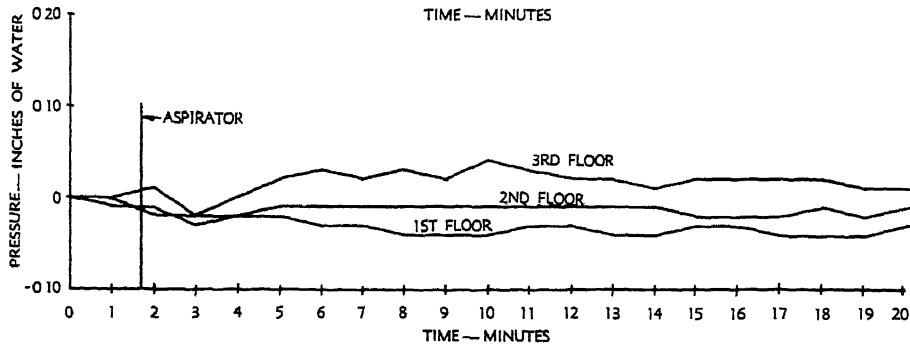
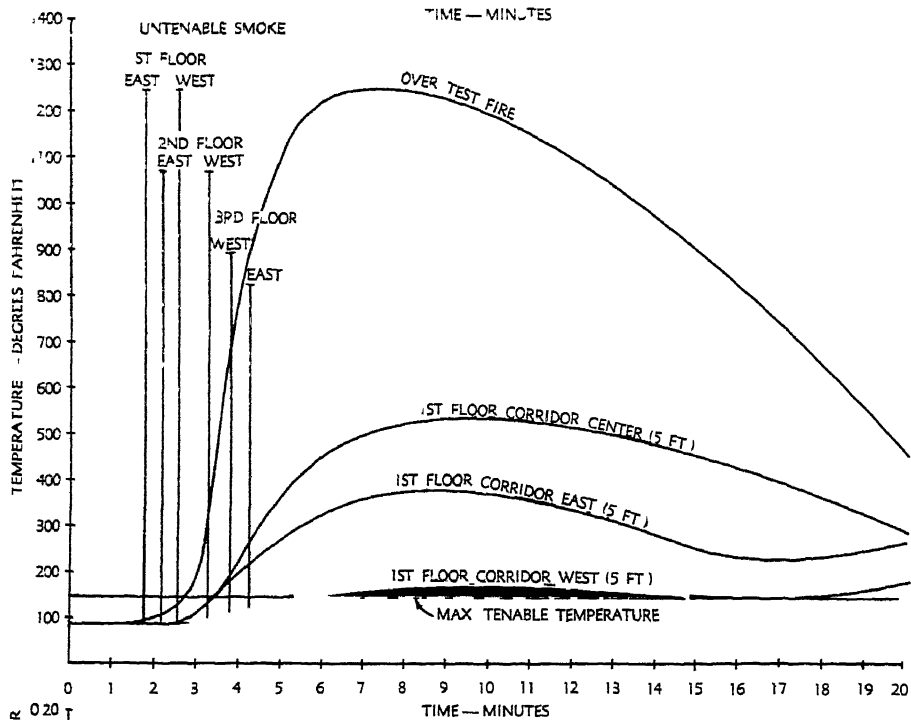
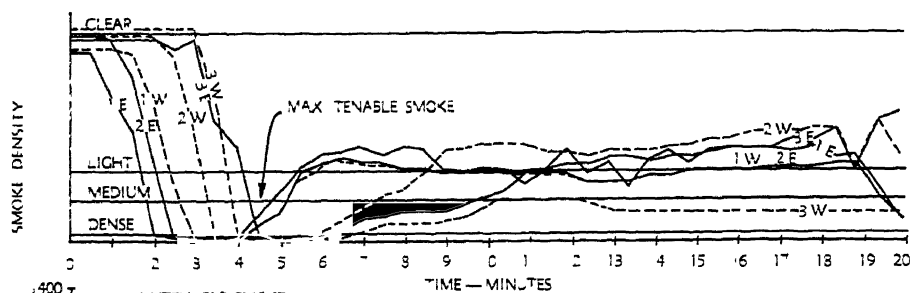
**Other:** Aspirator installed in vent above stairway No. 2. Vent open at fire start and aspirator started when signal received from automatic fire detection system circuit No. 5 (1 minute 40 seconds). Exit doors at west end of first floor corridor opened 30 seconds after aspirator started.

#### Comments:

Relatively fast developing test fire

Smoke conditions became untenable in all corridors quickly.

Aspirator started clearing smoke from all corridors 2 to 4 minutes after it was started. This is quicker than the vent with no aspirator. Operation of the aspirator resulted in immediate dense smoke conditions.



## Automatic Fire Detection System

Circuit No.	Area Covered	Response Time from Fire Start	
		Minutes	Seconds
1	1st Floor Corridor	2	15
2	2nd Floor Corridor	3	0
3	3rd Floor Corridor	4	5
4	Room 203	3	20
5	Stairway No 2	1	40
6	Stairway No. 1	1	55

## Temperature and Pressure Readings

FIRST FLOOR								
Time Min- utes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11	12U	12L	13U	13L	14U	14L	
1	80	90	80	90	90	90	80	0.00
2	95	115	85	90	90	90	80	0.00
3	140	270	115	130	120	100	85	-0.02
4	940	700	235	295	265	145	100	-0.02
5	1150	790	330	460	450	250	135	-0.02
6	1170	855	325	500	480	290	150	-0.03
7	1310	865	310	525	490	295	150	-0.03
8	1300	950	375	575	545	325	160	-0.04
9	1200	875	355	565	540	325	160	-0.04
10	1160	845	360	555	525	320	160	-0.04
11	1135	775	350	535	515	320	165	-0.03
12	1160	745	310	525	495	315	165	-0.03
13	960	650	295	485	460	295	155	-0.04
14	845	575	250	440	420	270	145	-0.04
15	815	560	225	420	400	260	140	-0.03
16	775	535	195	400	380	245	135	-0.03
17	745	445	205	395	370	245	135	-0.04
18	680	465	230	350	360	235	135	-0.04
19	490	390	260	345	325	245	160	-0.04
20	465	385	260	310	300	200	160	-0.03

# Temperature and Pressure Readings

SECOND FLOOR									
Time Minutes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	21	22U	22L	23U	23L	24U	24L	25	
1	85	85	85	90	90	90	90	90	-0.01
2	90	90	85	90	90	90	90	90	-0.01
3	140	115	95	95	95	95	90	95	-0.03
4	345	265	150	165	145	145	105	145	-0.02
5	450	345	200	250	225	225	145	235	-0.01
6	475	410	275	310	280	280	130	235	-0.01
7	490	430	325	345	320	305	205	240	-0.01
8	525	450	325	355	335	310	225	260	-0.01
9	510	450	340	360	345	315	225	255	-0.01
10	505	495	345	320	350	310	235	245	-0.01
11	490	430	325	360	340	310	230	250	-0.01
12	455	400	310	350	330	300	225	250	-0.01
13	425	380	300	330	320	290	220	230	-0.01
14	395	355	285	315	305	280	215	220	-0.01
15	375	335	270	300	290	265	210	210	-0.02
16	325	320	265	290	280	255	200	200	-0.02
17	345	310	250	280	270	250	200	200	-0.02
18	325	290	235	270	260	240	195	200	-0.01
19	290	270	225	255	250	230	190	205	-0.02
20	290	270	225	240	240	210	175	200	-0.01

THIRD FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	31	32U	32L	33U	33L	34U	34L	35	
1	85	85	90	90	90	90	90	90	0.00
2	85	85	90	90	90	90	90	90	-0.02
3	105	90	90	90	90	90	90	90	-0.02
4	180	110	95	95	95	110	95	115	0.00
5	260	190	120	125	115	155	130	175	0.02
6	275	150	145	155	150	190	165	215	0.03
7	245	185	165	175	175	205	155	225	0.02
8	280	210	175	175	170	210	195	230	0.03
9	290	225	175	185	185	215	195	230	0.02
10	230	200	180	190	190	215	200	225	0.04
11	205	200	185	190	190	210	200	230	0.03
12	215	210	185	190	190	205	195	220	0.02
13	215	200	180	185	185	200	190	215	0.02
14	205	195	180	180	185	195	185	205	0.01
15	210	195	175	180	180	190	185	200	0.02
16	195	180	170	175	175	190	180	195	0.02
17	185	175	170	175	175	185	180	195	0.02
18	185	165	165	170	170	180	170	190	0.02
19	175	160	160	165	165	175	165	190	0.01
20	175	160	150	160	150	170	160	180	0.01

**Test I-2**

**Date:** April 29, 1959

**Outdoor Temperature:** 82° F. **Humidity:** 33% **Wind:** 5.5  
m p h W Average

**Fuel:** 1,400 pounds of pallets

**Location of Test Fire:** Base of stairway No 2

**Automatic Sprinklers:** None

**Vents:** 40 square feet at top of stairway No 2

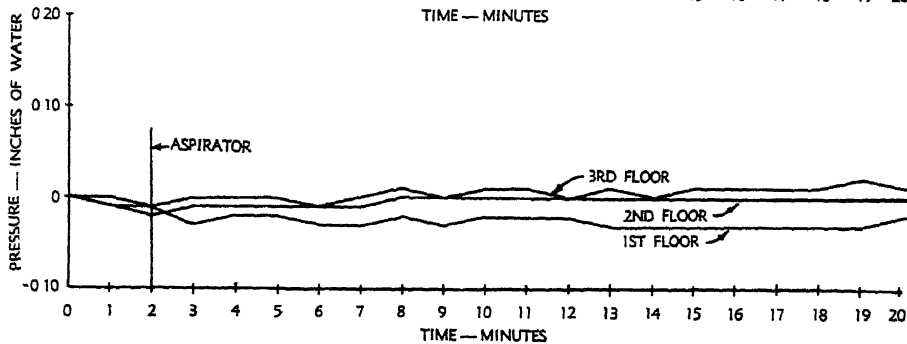
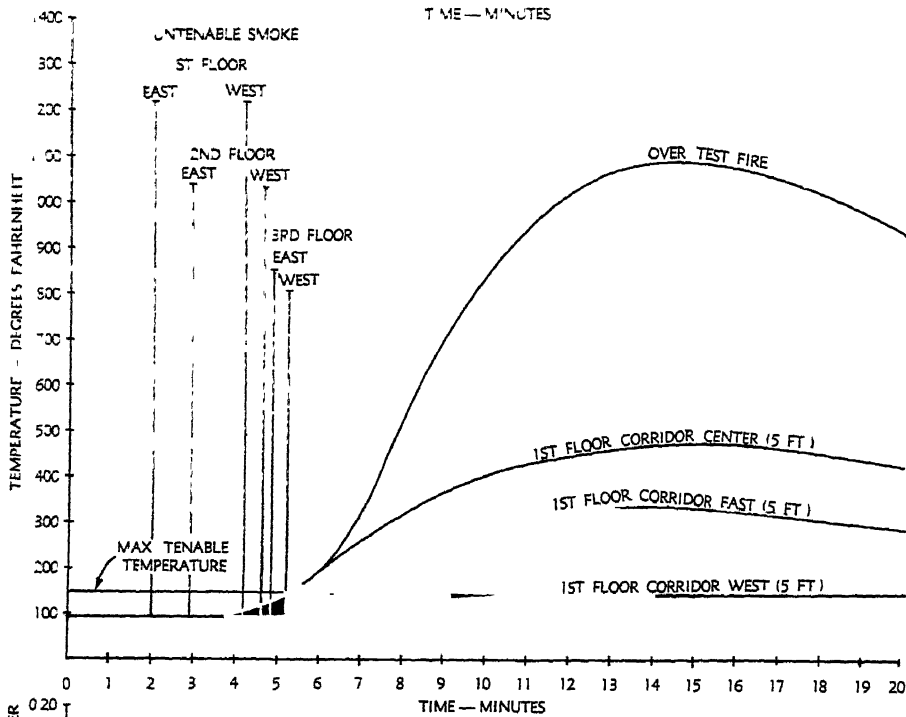
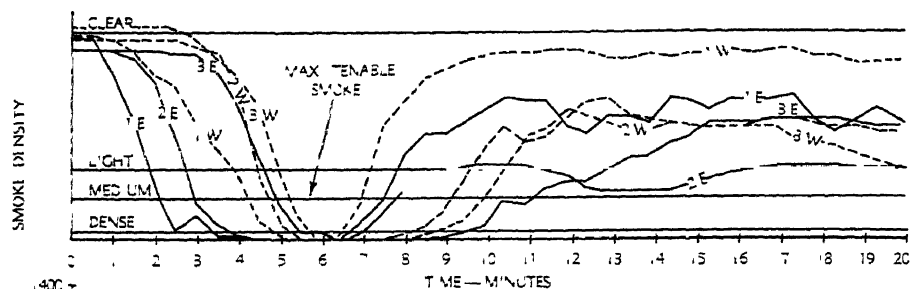
**Curtain Boards:** Corridors only

**Automatic Fire Detection:** Coverage as shown in Figure 12

**Other:** Aspirator installed at vent at top of stairway No 2. Vent open at fire start and aspirator started 2 minutes after start of test fire. All classroom doors to corridors and corridor exit doors opened 30 seconds after aspirator started

**Comments:**

Aspirator started to clear corridors 4 to 6 minutes after it was started. This is more rapid than was obtained in a comparable test without the aspirator. Open classroom doors slowed action of aspirator.



## Automatic Fire Detection System

Circuit No.	Area Covered	Response Time from Fire Start	
		Minutes	Seconds
1	1st Floor Corridor	3	33
2	2nd Floor Corridor	4	50
3	3rd Floor Corridor	6	25
4	Room 203	5	25
5	Stairway No. 2	2	50
6	Stairway No. 1	2	10

## Temperature and Pressure Readings

FIRST FLOOR								
Time Min- utes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11	12U	12L	13U	13L	14U	14L	
1	85	105	100	110	105	105	95	-0.01
2	95	110	100	110	105	105	95	-0.01
3	95	130	105	115	110	105	95	-0.03
4	110	170	120	125	115	105	95	-0.02
5	120	235	120	160	150	115	95	-0.02
6	155	405	175	255	245	145	105	-0.03
7	695	545	240	300	295	170	120	-0.03
8	685	545	220	360	335	205	120	-0.02
9	860	630	275	390	365	225	120	-0.03
10	915	660	280	410	400	250	125	-0.02
11	1025	670	290	440	415	260	125	-0.02
12	1045	720	330	460	435	260	130	-0.02
13	1015	780	335	485	460	280	135	-0.03
14	1065	795	350	495	470	280	140	-0.03
15	1060	730	295	505	475	285	145	-0.03
16	1125	690	285	475	450	285	140	-0.03
17	1005	665	275	455	430	280	135	-0.03
18	1010	685	305	450	430	275	135	-0.03
19	985	715	325	470	445	280	145	-0.03
20	915	600	290	465	440	280	145	-0.02

## Temperature and Pressure Readings

SECOND FLOOR									
Time Minutes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	21	22U	22L	23U	23L	24U	24L	25	
1	105	100	95	100	100	100	100	100	0.00
2	110	100	105	100	100	100	100	100	-0.01
3	110	105	95	105	105	105	100	100	0.00
4	130	115	100	105	105	105	95	100	0.00
5	155	130	105	115	115	110	100	110	0.00
6	235	210	135	155	145	145	105	140	-0.01
7	330	220	175	175	165	165	115	160	-0.01
8	350	290	195	210	200	195	125	150	0.00
9	365	305	210	235	225	215	145	190	0.00
10	395	350	230	260	245	235	160	205	0.00
11	405	340	240	275	255	245	170	210	0.00
12	430	355	250	290	275	255	175	215	0.00
13	445	365	260	300	285	265	130	230	0.00
14	455	380	265	305	290	270	185	230	0.00
15	435	350	260	315	300	275	185	235	0.00
16	405	350	265	305	290	265	185	225	0.00
17	405	345	260	295	280	260	185	220	0.00
18	405	350	260	290	275	255	185	220	0.00
19	415	355	265	295	275	260	135	225	0.00
20	390	335	250	295	275	260	185	230	0.00

THIRD FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	31	32U	32L	33U	33L	34U	34L	35	
1	95	90	95	95	95	95	95	95	-0.01
2	95	95	95	95	95	95	95	95	-0.02
3	100	95	95	95	95	95	95	95	-0.01
4	105	95	95	95	95	95	95	100	-0.01
5	110	95	100	100	100	100	100	100	-0.01
6	165	125	105	100	95	110	100	115	-0.01
7	210	170	110	105	100	120	110	125	0.00
8	230	185	125	115	110	135	125	145	0.01
9	250	190	130	125	120	145	135	160	0.00
10	260	190	135	140	130	155	145	175	0.01
11	265	210	145	145	135	165	155	180	0.01
12	270	230	155	155	150	170	165	185	0.00
13	290	230	160	160	155	180	170	195	0.01
14	305	250	165	165	160	180	175	195	0.00
15	280	255	175	170	165	180	180	195	0.01
16	270	240	175	170	170	180	180	195	0.01
17	270	225	170	165	165	180	175	190	0.01
18	280	215	165	165	165	180	175	195	0.01
19	270	225	170	170	165	180	180	195	0.02
20	215	220	170	170	170	180	180	190	0.01

**Test I-3**

**Date:** May 8, 1959

**Outdoor Temperature:** 73° F   **Humidity:** 64%   **Wind:** 6.2  
m p h. W Average

**Fuel:** 1,400 pounds of pallets

**Location of Test Fire:** Base of stairway No. 2

**Automatic Sprinklers:** None

**Vents:** 40 square feet at top of stairway No. 2

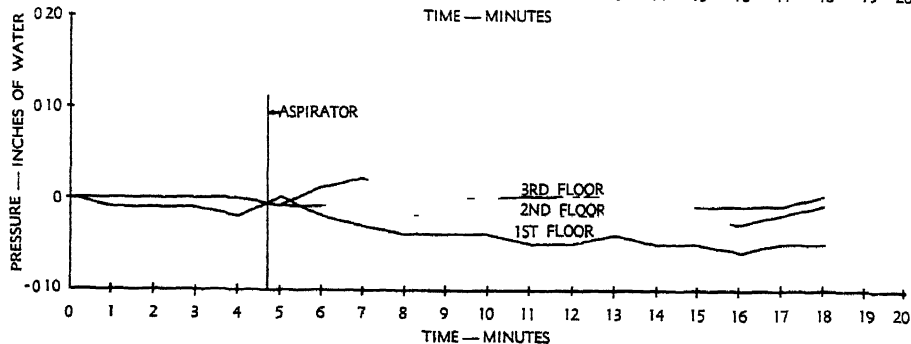
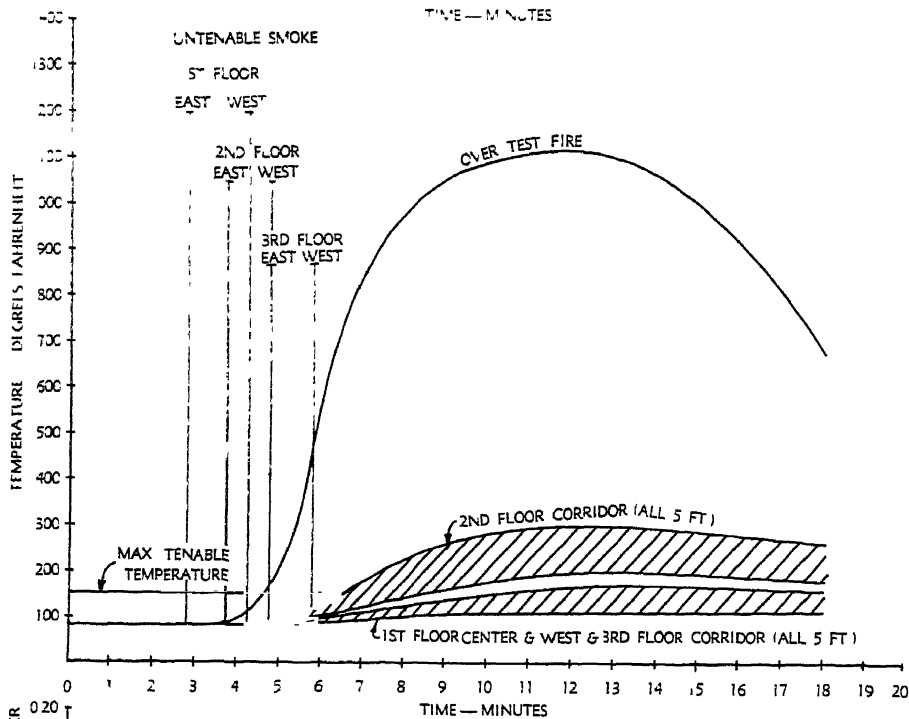
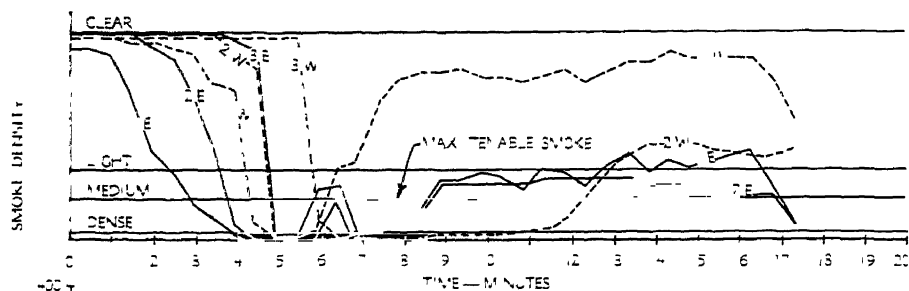
**Curtain Boards:** Second and third floor corridors only

**Automatic Fire Detection:** None

**Other:** Aspirator installed in vent above stairway No. 2. Vent open at fire start and aspirator started when temperature at thermocouple nearest test fire reached 150 degrees Fahrenheit. Exit doors at west end of first floor corridor opened 30 seconds after aspirator started.

**Comments:**

Smoke became very dense immediately following the starting of the aspirator but clearing started sooner ( $\frac{1}{2}$  to  $1\frac{1}{2}$  minutes) than in tests with a similar vent and no aspirator



## Temperature and Pressure Readings

FIRST FLOOR								
Time Min- utes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11	12U	12L	13U	13L	14U	14L	
1	85	75	75	85	85	85	75	-0.01
2	85	75	75	85	85	85	75	-0.01
3	90	80	75	85	85	85	75	-0.01
4	115	95	80	85	85	85	75	-0.02
5	155	115	85	85	85	85	75	0.00
6	645	415	155	155	85	110	85	-0.02
7	985	620	240	235	110	200	110	-0.03
8	960	635	255	250	115	215	105	-0.04
9	1045	720	295	265	110	240	120	-0.04
10	1080	685	280	240	110	225	120	-0.04
11	1115	730	280	255	110	240	125	-0.05
12	1050	720	290	270	115	255	130	-0.05
13	1100	710	230	260	115	260	125	-0.04
14	1100	695	260	275	120	240	130	-0.05
15	955	645	240	255	110	240	120	-0.05
16	925	635	210	250	110	230	115	-0.06
17	875	595	180	235	110	230	115	-0.05
18	675	460	120	245	110	235	120	-0.05
19								
20								

[illegible]



## Series J

### Vents, Sprinklers, and Curtain Boards

This series of tests combines three of the previously tested devices simultaneously to determine their effectiveness for life safety. Tests in this series include vents, automatic sprinklers and curtain boards. No sprinkler was installed above the test fire except in Test J-5.

#### Test J-1

**Date:** April 25, 1959

**Outdoor Temperature:** 67° F. **Humidity:** 93% **Wind:** 6.1 m.p.h. S Average

**Fuel:** 1,400 pounds of pallets

**Location of Test Fire:** Base of stairway No. 2

**Automatic Sprinklers:** At stairway openings to corridors

**Vents:** 21 square feet at top of stairway No. 2

**Curtain Boards:** Corridors and stairway openings to corridors

**Automatic Fire Detection:** Coverage as shown in Figure 12

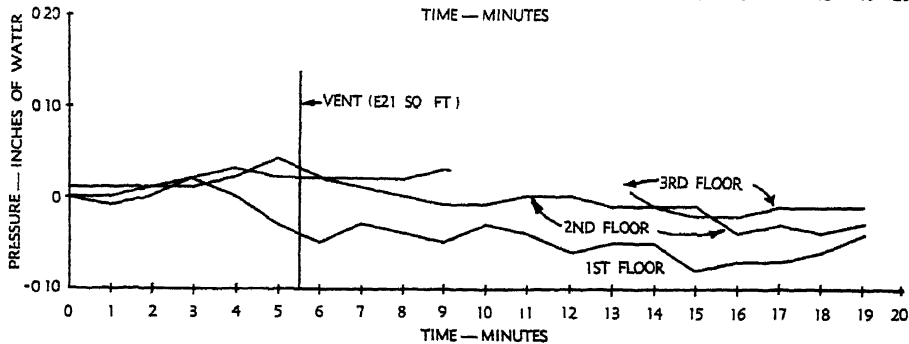
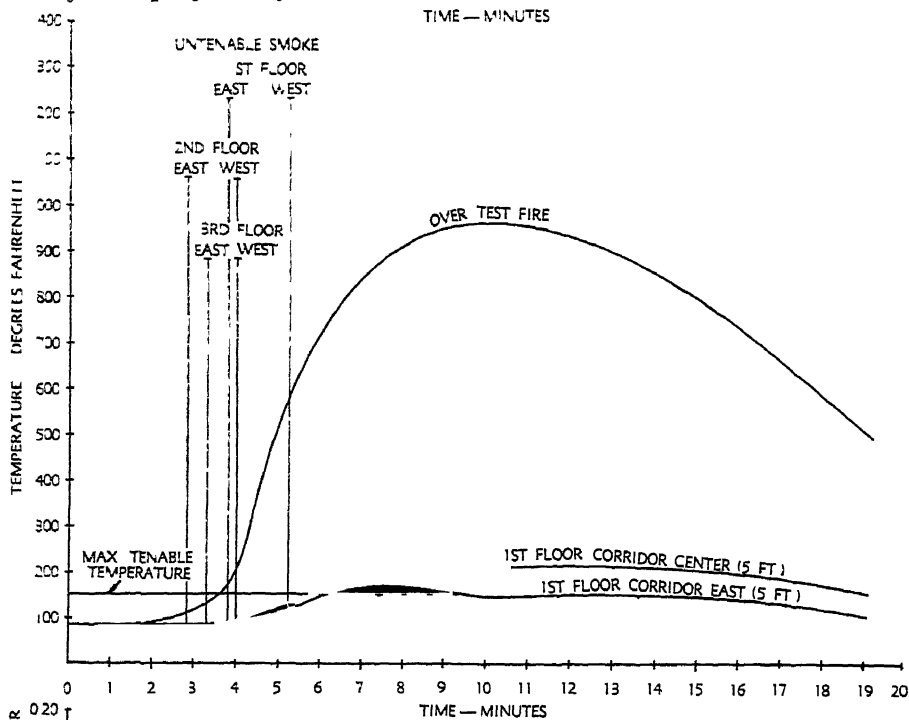
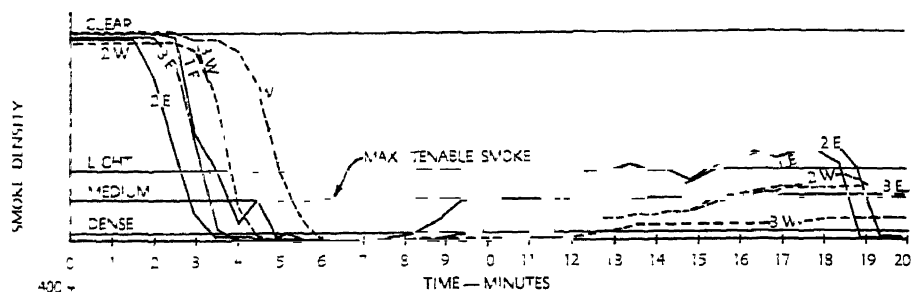
**Other:** Vent opened with operation of fusible link rated at 165 degrees Fahrenheit.

#### Comments:

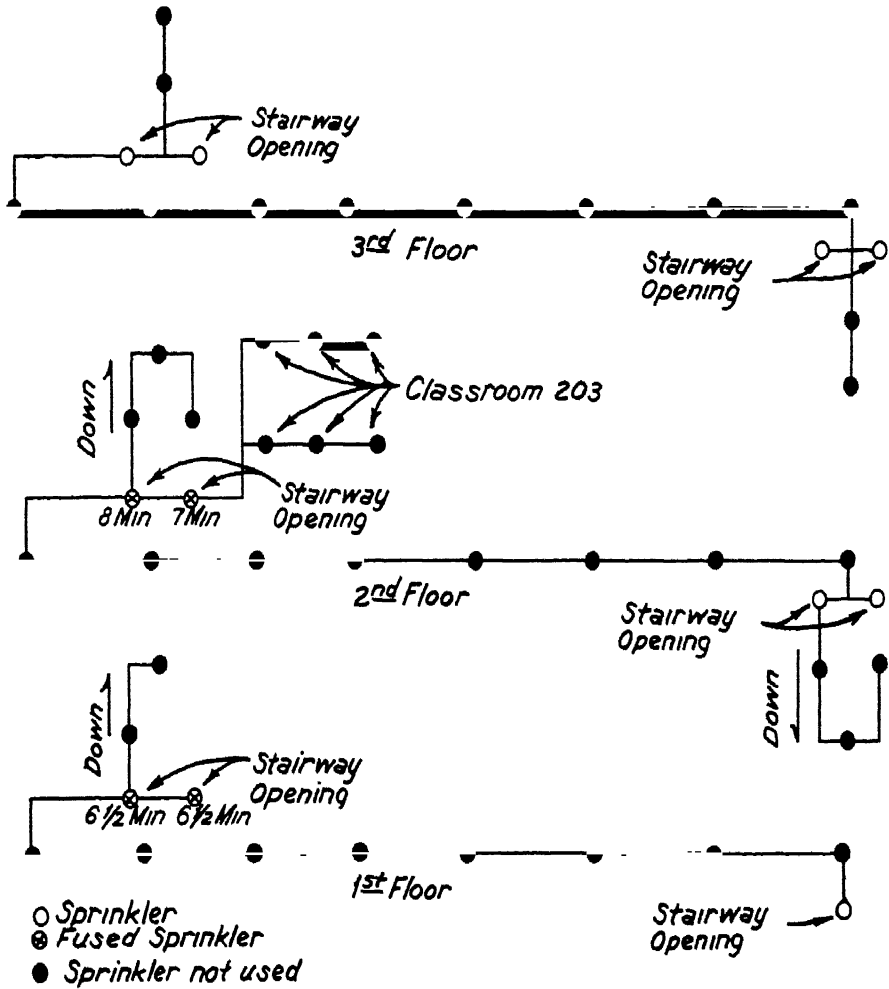
Untenable smoke conditions existed in all corridors before the vent opened or any sprinklers operated.

Sprinklers did not prevent spread of smoke but did decrease temperatures at thermocouples near them.

Vent (opened in 5½ minutes) failed to clear smoke from the building.



## Automatic Sprinkler Operation



## Comments on Sprinkler Operation:

Sprinklers Utilized: stairway openings only.

## Automatic Fire Detection System

Circuit No.	Area Covered	Response Time from Fire Start	
		Minutes	Seconds
1	1st Floor Corridor	3	40
2	2nd Floor Corridor	4	10
3	3rd Floor Corridor	4	40
4	Room 203	4	20
5	Stairway No. 2	3	10
6	Stairway No. 1	4	40

## Temperature and Pressure Readings

FIRST FLOOR								
Time Min- utes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11	12U	12L	13U	13L	14U	14L	
1	75	75	75	85	85	85	70	-0.01
2	85	75	75	80	80	80	75	0.00
3	115	85	75	80	80	20	75	0.02
4	160	105	80	75	90	70	75	0.00
5	550	140	90	125	110	85	75	-0.03
6	785	135	185	190	170	95	75	-0.05
7	825	135	190	195	175	115	90	-0.03
8	955	135	135	195	185	130	100	-0.04
9	940	140	135	205	190	140	120	-0.05
10	965	140	135	220	200	150	120	-0.03
11	955	135	135	225	210	155	125	-0.04
12	965	135	140	225	210	165	135	-0.06
13	950	135	140	210	200	165	135	-0.05
14	890	125	140	200	185	160	135	-0.05
15	775	135	135	195	175	150	130	-0.08
16	705	125	125	195	180	150	125	-0.07
17	650	120	130	185	175	150	125	-0.07
18	610	120	125	180	175	150	125	-0.06
19	335	110	115	175	165	150	125	-0.04
20								

### Temperature and Pressure Readings

[illegible][illegible]

### Test J-2

**Date:** April 25, 1959

**Outdoor Temperature:** 65° F. **Humidity:** 93% **Wind:** 6 1  
m.p.h. S Average

**Fuel:** 1,400 pounds of pallets

**Location of Test Fire:** Base of stairway No. 2

**Automatic Sprinklers:** Corridors only

**Vents:** 42 square feet at top of stairway No. 2

**Curtain Boards:** Corridors only

**Automatic Fire Detection:** Coverage as shown in Figure 12

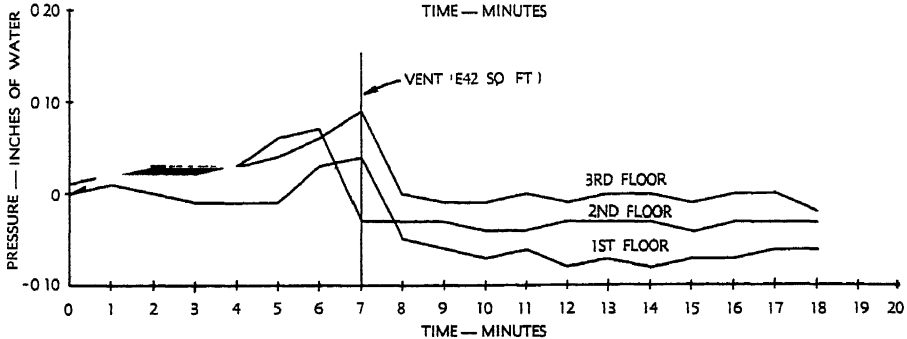
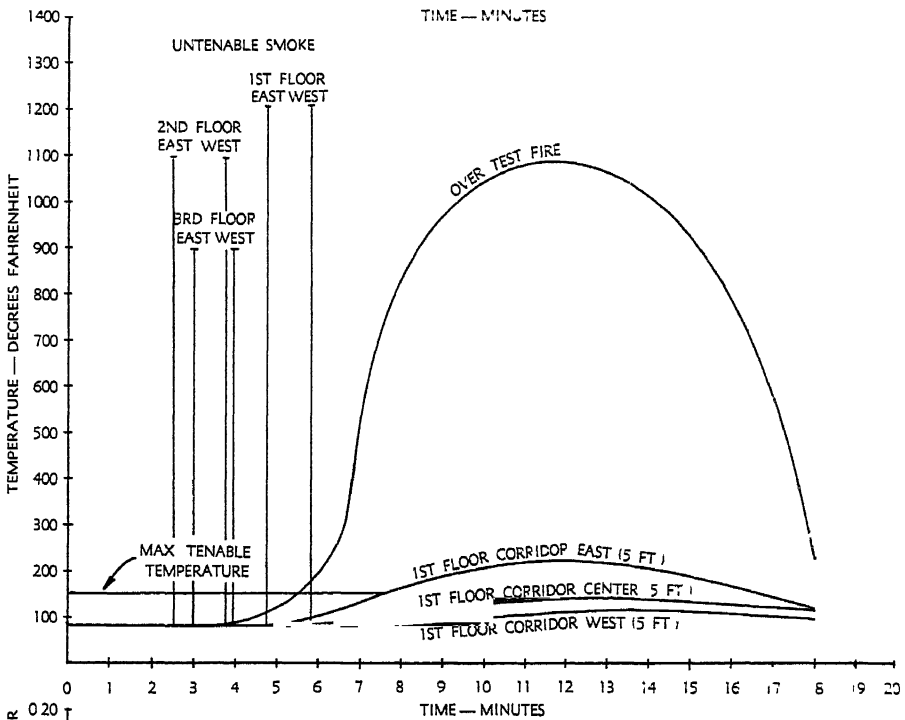
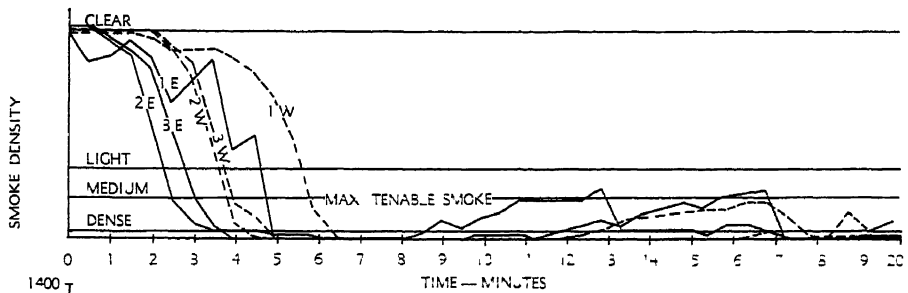
**Other:** Vent opened with operation of fusible link rated at 165  
degrees Fahrenheit.

**Comments:**

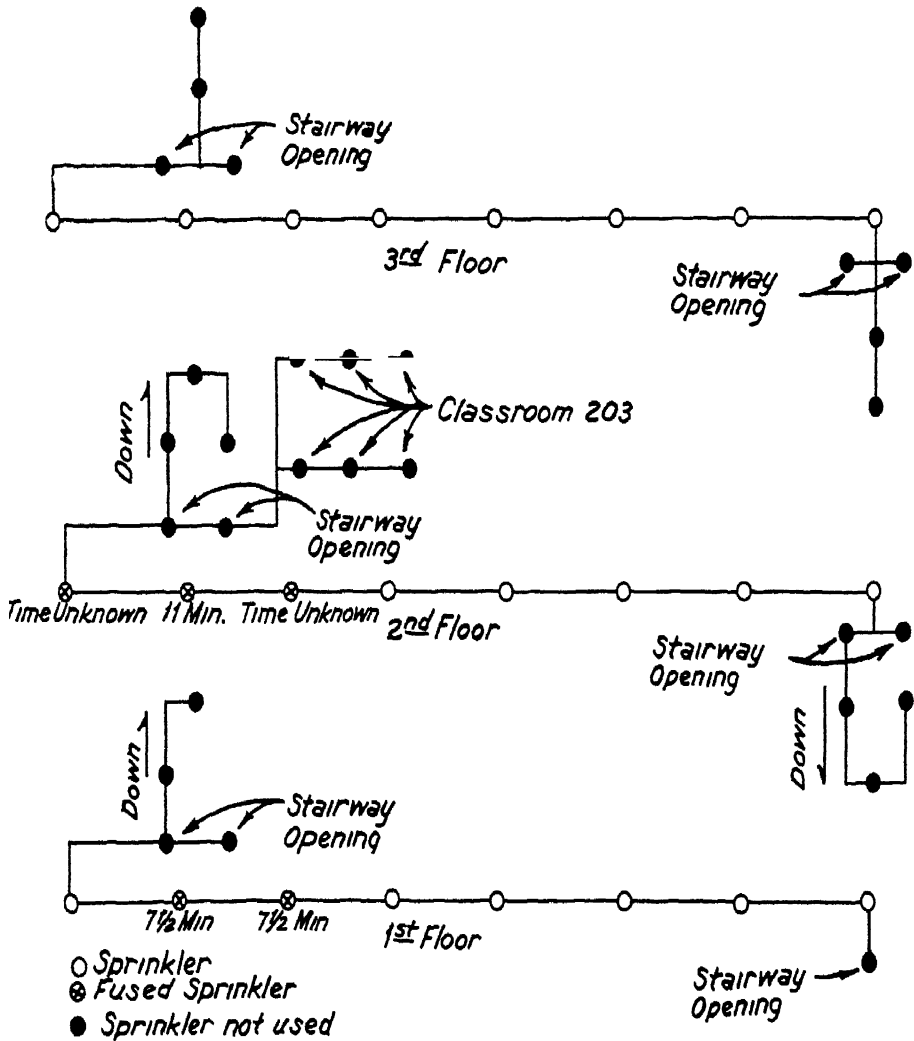
Untenable smoke conditions in all corridors before  
sprinklers operated or vent opened

Vent (opened in 7 minutes) failed to clear smoke from  
any corridor.

Sprinklers did not prevent smoke spread but did de-  
crease temperatures to some extent on the west end of the  
first floor corridor.



## Automatic Sprinkler Operation



## Comments on Sprinkler Operation:

Sprinklers Utilized. corridors only.

## Automatic Fire Detection System

Circuit No.	Area Covered	Response Time from Fire Start	
		Minutes	Seconds
1	1st Floor Corridor	5	22
2	2nd Floor Corridor	5	35
3	3rd Floor Corridor	6	25
4	Room 203	6	25
5	Stairway No. 2	5	2
6	Stairway No. 1	6	5

## Temperature and Pressure Readings

FIRST FLOOR								
Time Min- utes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11	12U	12L	13U	13L	14U	14L	
1	85	80	80	85	85	85	75	0.01
2	90	85	80	85	85	85	75	0.00
3	100	85	80	85	85	85	75	-0.01
4	120	85	80	90	90	85	75	-0.01
5	135	95	85	100	95	85	75	-0.01
6	185	130	100	130	115	90	75	0.03
7	390	230	165	155	140	90	75	0.04
8	925	140	185	155	130	90	85	-0.05
9	930	120	165	140	125	100	95	-0.06
10	1025	125	210	140	130	125	100	-0.07
11	1055	120	195	140	140	120	105	-0.06
12	1065	120	200	145	135	120	105	-0.08
13	1150	125	220	150	140	120	110	-0.07
14	960	125	185	150	140	125	120	-0.08
15	870	125	175	145	135	125	120	-0.07
16	810	120	135	130	130	120	115	-0.07
17	495	110	120	130	125	120	110	-0.06
18	230	90	95	125	120	120	105	-0.06
19								
20								

### Temperature and Pressure Readings

[illegible][illegible]

**Test J-3**

**Date:** April 25, 1959

**Outdoor Temperature:** 62° F. **Humidity:** 93% **Wind:** 6.1  
m p.h. S Average

**Fuel:** 1,400 pounds of pallets

**Location of Test Fire:** Base of stairway No. 2

**Automatic Sprinklers:** Corridors and in stairways

**Vents:** 42 square feet at top of stairway No. 2

**Curtain Boards:** At stairway openings to corridors

**Automatic Fire Detection:** Coverage as shown in Figure 12

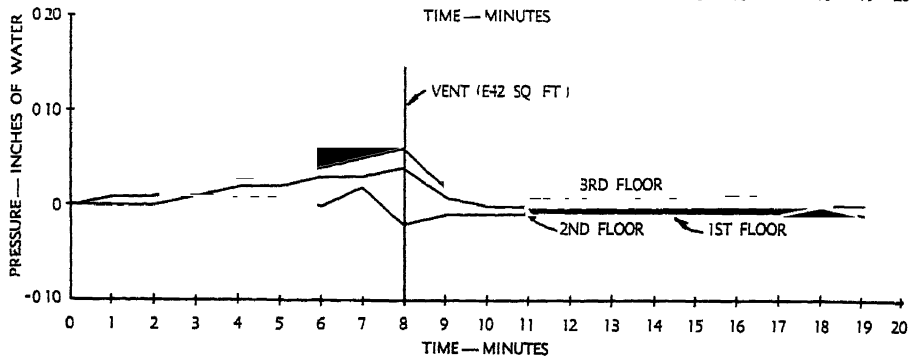
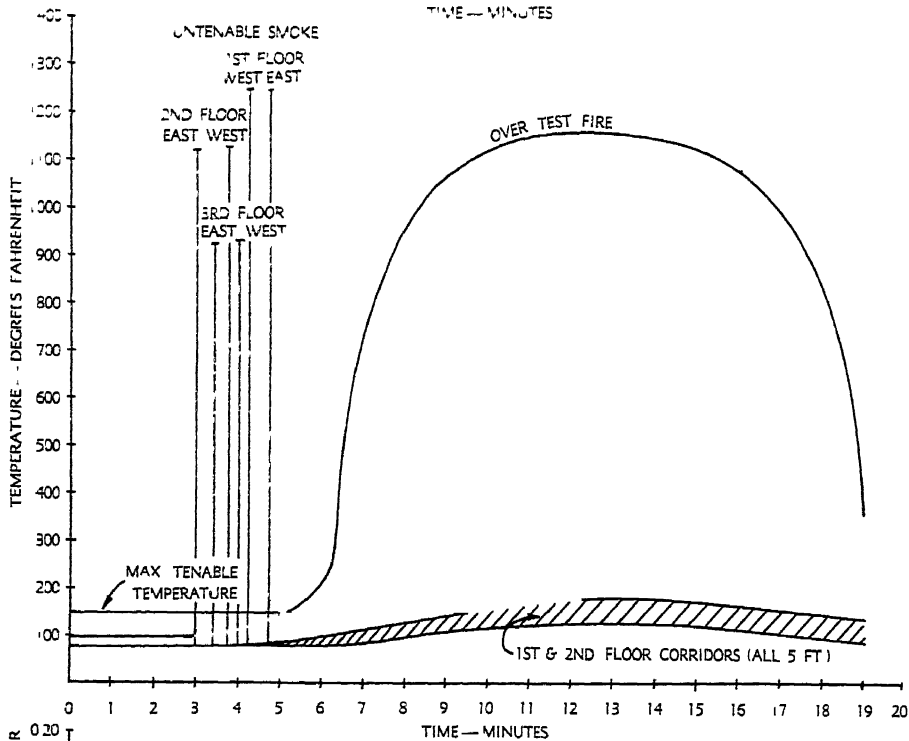
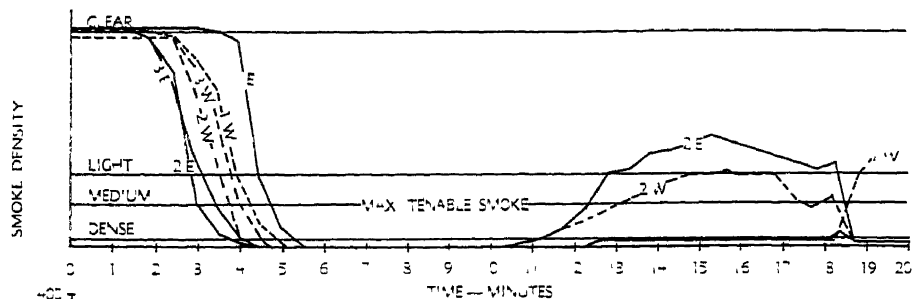
**Other:** Vent and exit doors at west end of first floor corridor  
opened arbitrarily 8 minutes after start of test fire.

**Comments:**

All corridors untenable from smoke before any sprinklers  
operated or vent opened

Second floor corridor started to clear of smoke 3 minutes  
after vent opened.

Sprinklers decreased temperatures in first and second  
floor corridors



The diagram illustrates the fire spread from Classroom 203 on the 2nd floor. The fire spread is shown through stairways and corridors, with time markers indicating the arrival of fire at various points.

**Legend:**

- Sprinkler
- ⊗ Fused Sprinkler
- Sprinkler not used

**Fire Spread Details:**

- Classroom 203 (2nd Floor):** Fire originates here, spreading into the stairway. Time markers: 7 Min (down), 5 1/2 Min (up), and Unknown (down).
- Stairway Opening (2nd Floor):** Fire spreads from Classroom 203 into the stairway. Time marker: 11 1/2 Min.
- Stairway Opening (1st Floor):** Fire spreads from the 2nd floor stairway into the 1st floor stairway. Time marker: 8 Min.
- Stairway Opening (3rd Floor):** Fire spreads from the 1st floor stairway into the 3rd floor stairway. Time marker: 8 Min.
- Stairway Opening (2nd Floor):** Fire spreads from the 1st floor stairway into the 2nd floor stairway. Time marker: 11 Min.
- Stairway Opening (3rd Floor):** Fire spreads from the 2nd floor stairway into the 3rd floor stairway. Time marker: 11 Min.
- Stairway Opening (2nd Floor):** Fire spreads from the 1st floor stairway into the 2nd floor stairway. Time marker: 11 Min.
- Stairway Opening (3rd Floor):** Fire spreads from the 2nd floor stairway into the 3rd floor stairway. Time marker: 11 Min.

Sprinklers Utilized: corridors and stairways.

## Automatic Fire Detection System

Circuit No.	Area Covered	Response Time from Fire Start	
		Minutes	Seconds
1	1st Floor Corridor	5	0
2	2nd Floor Corridor	5	40
3	3rd Floor Corridor	6	58
4	Room 203	6	59
5	Stairway No. 2	5	15
6	Stairway No. 1	6	15

## Temperature and Pressure Readings

FIRST FLOOR								
Time Min- utes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11	12U	12L	13U	13L	14U	14L	
1	90	80	80	85	85	85	75	0.00
2	100	80	80	85	85	85	75	0.00
3	105	80	80	90	90	90	75	0.01
4	120	85	80	90	85	85	80	0.01
5	130	85	80	100	90	90	80	0.01
6	170	100	85	110	90	95	80	0.00
7	950	110	90	140	105	115	85	0.02
8	1055	145	115	175	120	145	95	-0.02
9	1070	210	115	170	125	150	125	-0.01
10	1090	115	140	150	110	145	125	-0.01
11	1110	130	125	140	100	135	95	-0.01
12	1200	115	135	140	95	130	95	-0.01
13	1155	115	125	145	95	130	100	-0.01
14	1145	120	135	150	95	135	100	-0.01
15	1115	115	135	150	95	135	100	-0.01
16	1080	115	130	150	95	140	100	-0.01
17	960	145	125	150	95	140	95	-0.01
18	855	95	110	145	90	135	90	0.00
19	355	105	105	135	90	130	85	0.00
20								

## Temperature and Pressure Readings

[illegible][illegible]

### Test J-4

**Date:** April 25, 1959

**Outdoor Temperature:** 60° F   **Humidity:** 93%   **Wind:** 6 1  
m p h. S Average

**Fuel:** 1,400 pounds of pallets

**Location of Test Fire:** Base of stairway No 2

**Automatic Sprinklers:** Corridors and in stairways

**Vents:** 42 square feet at top of stairway No 2

**Curtain Boards:** Corridors only

**Automatic Fire Detection:** Coverage as shown in Figure 12

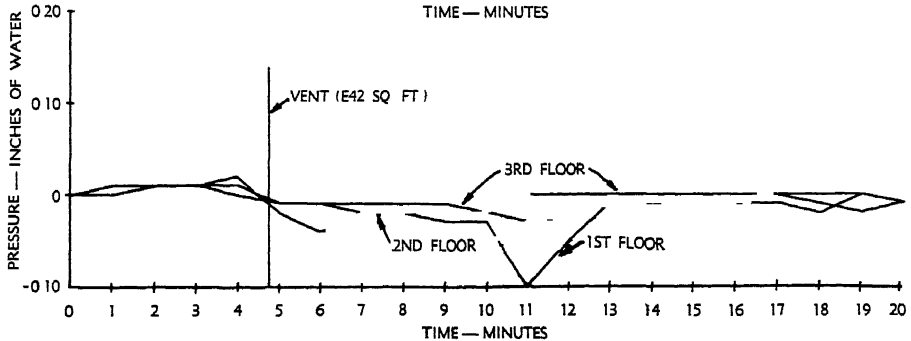
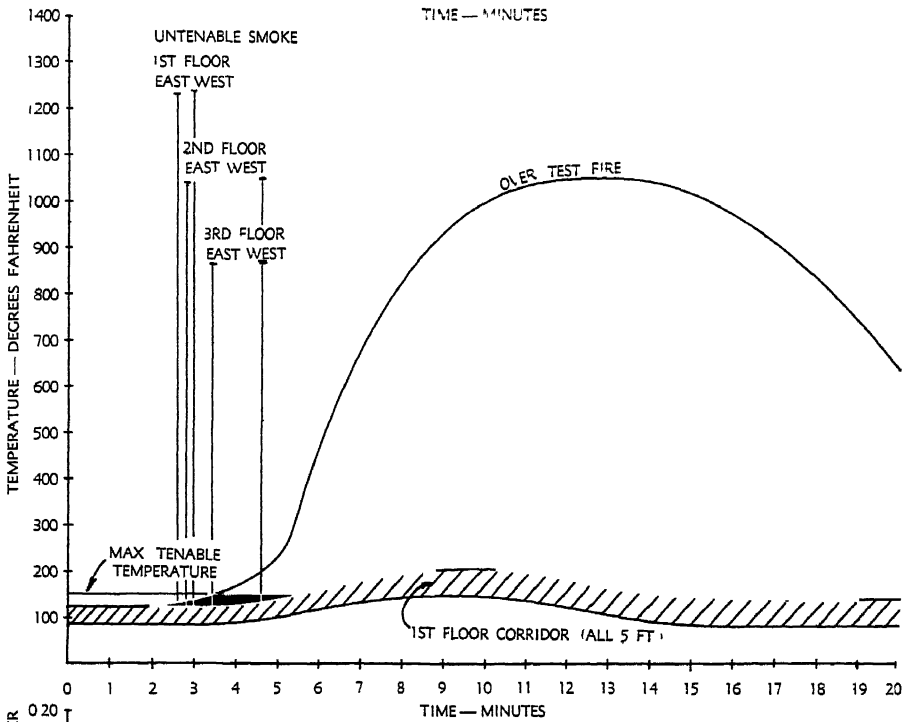
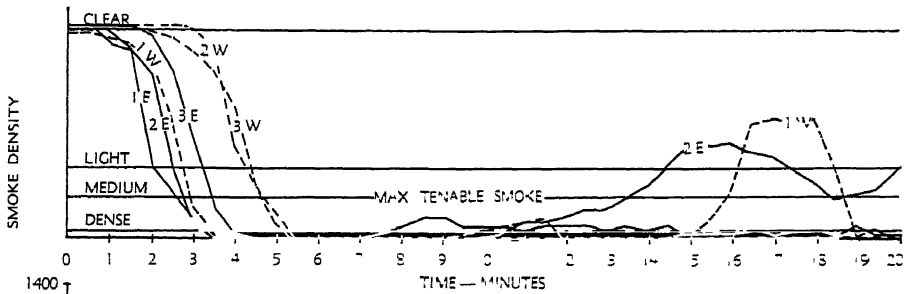
**Other:** Vent opened at operation of first sprinkler   Exit doors  
at west end of first floor corridor opened 8 minutes after  
vent operated

#### Comments:

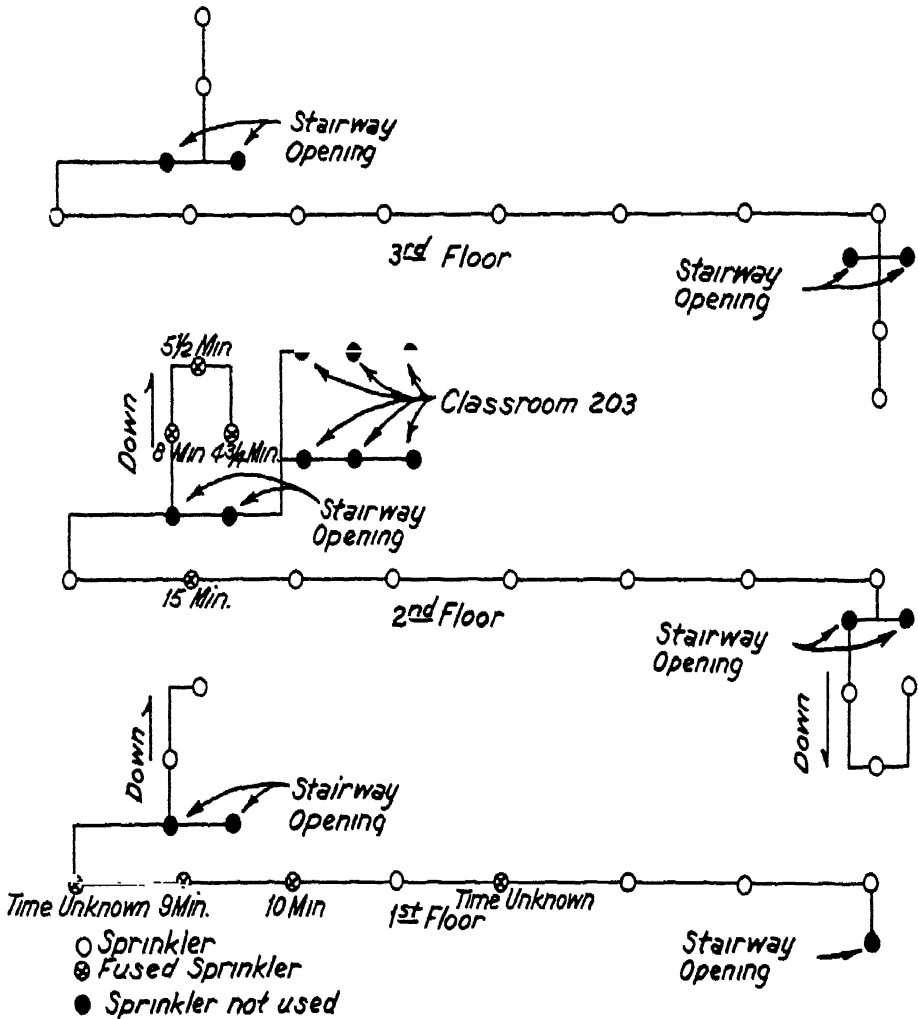
All corridors untenable from smoke before operation of  
any sprinklers or opening of vent.

Curtain boards in corridors decreased effectiveness of  
sprinklers in cooling temperatures in corridors and in effec-  
tiveness of vent to clear west end of second floor corridor

Operation of sprinklers drove smoke to floors and re-  
sulted in generation of steam



## Automatic Sprinkler Operation



## Comments on Sprinkler Operation:

Sprinklers Utilized: corridors and stairways

## Automatic Fire Detection System

Circuit No.	Area Covered	Response Time from Fire Start	
		Minutes	Seconds
1	1st Floor Corridor	3	30
2	2nd Floor Corridor	6	8
3	3rd Floor Corridor	8	0
4	Room 203	No response.	
5	Stairway No. 2	3	15
6	Stairway No. 1	5	40

## Temperature and Pressure Readings

FIRST FLOOR								
Time Min- utes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11	12U	12L	13U	13L	14U	14L	
1	120	100	80	100	90	90	80	0.01
2	125	115	85	105	95	95	80	0.01
3	135	135	90	110	105	95	85	0.01
4	130	160	95	120	115	100	90	0.02
5	140	155	100	135	125	105	105	-0.02
6	190	200	130	165	150	115	120	-0.01
7	875	230	130	195	175	150	135	-0.02
8	910	275	170	185	160	155	140	-0.02
9	940	280	200	190	165	150	125	-0.03
10	985	320	185	175	175	155	145	-0.03
11	1090	290	170	160	170	150	145	-0.04
12	1110	300	180	160	170	155	120	-0.05
13	1070	255	155	150	155	135	100	-0.01
14	1025	230	150	145	150	125	90	-0.01
15	965	155	145	150	150	115	85	-0.01
16	955	155	140	150	150	110	80	-0.01
17	950	150	135	150	150	110	80	-0.01
18	870	150	140	145	145	105	80	-0.02
19	810	145	135	145	145	110	85	0.00
20	640	130	130	135	140	115	85	-0.01

## Temperature and Pressure Readings

SECOND FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	21	22U	22L	23U	23L	24U	24L	25	
1	95	85	85	90	90	95	90	90	0.00
2	100	90	85	90	90	95	90	90	0.01
3	110	90	85	90	95	95	90	90	0.01
4	120	95	90	95	100	100	90	90	0.01
5	125	105	95	100	100	100	90	100	-0.01
6	140	115	100	110	110	110	95	115	-0.01
7	165	130	110	125	125	120	105	135	-0.02
8	180	135	125	135	135	130	120	140	-0.02
9	140	135	125	135	130	130	125	140	-0.02
10	145	140	130	135	135	135	130	150	-0.02
11	145	140	130	140	140	140	135	150	-0.03
12	150	145	130	145	145	140	135	145	-0.03
13	155	145	140	150	150	145	130	125	-0.01
14	165	145	130	155	150	145	125	115	-0.01
15	170	135	135	155	145	145	120	110	-0.01
16	175	130	135	150	145	145	120	105	-0.01
17	175	125	135	150	145	140	120	105	0.00
18	160	125	135	150	145	140	115	105	0.00
19	155	125	130	150	140	140	115	105	0.00
20	145	115	125	145	140	140	110	105	-0.01

THIRD FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	31	32U	32L	33U	33L	34U	34L	35	
1	85	90	90	90	90	90	90	90	0.01
2	90	90	95	90	90	90	90	90	0.01
3	90	90	95	90	90	90	90	90	0.01
4	95	95	100	90	95	95	90	90	0.00
5	100	105	105	95	100	100	95	95	-0.01
6	105	105	100	100	100	100	95	100	-0.01
7	110	110	105	100	100	110	100	110	-0.01
8	120	120	110	110	105	120	110	125	-0.01
9	120	120	115	110	110	125	115	125	-0.01
10	120	115	115	120	120	130	125	125	-0.02
11	125	120	120	125	125	130	130	140	0.00
12	125	125	125	130	130	135	130	140	0.00
13	130	130	135	130	130	130	130	135	0.00
14	130	130	130	125	130	130	130	130	0.00
15	130	130	130	125	130	130	125	130	0.00
16	130	130	125	125	130	130	125	130	0.00
17	125	125	125	125	125	130	125	130	0.00
18	125	125	125	120	125	125	120	130	-0.01
19	125	125	125	120	125	125	125	125	-0.02
20	120	120	125	120	125	125	125	125	-0.01

### Test J-5

**Date:** April 30, 1959

**Outdoor Temperature:** 73° F   **Humidity:** 70%   **Wind:** 6 8  
m p.h W Average

**Fuel:** 700 pounds of pallets. Top and middle pallets solid

**Location of Test Fire:** Landing between basement and first  
floor of stairway No 2

**Automatic Sprinklers:** Corridors and stairways

**Vents:** 42-square feet at top of stairway No. 2

**Curtain Boards:** Corridors only

**Automatic Fire Detection:** Coverage as shown in Figure 12

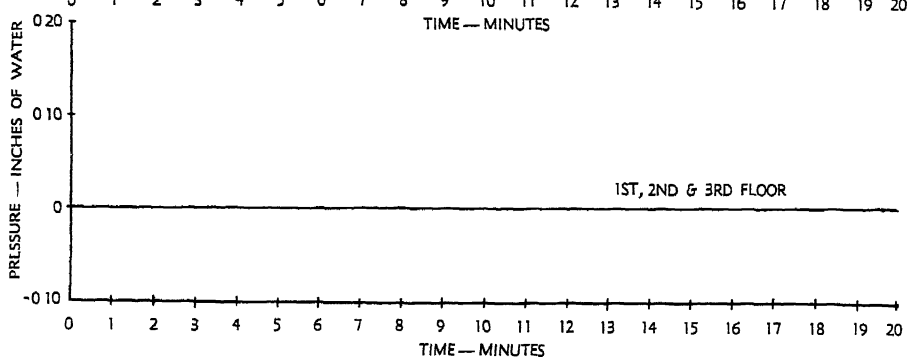
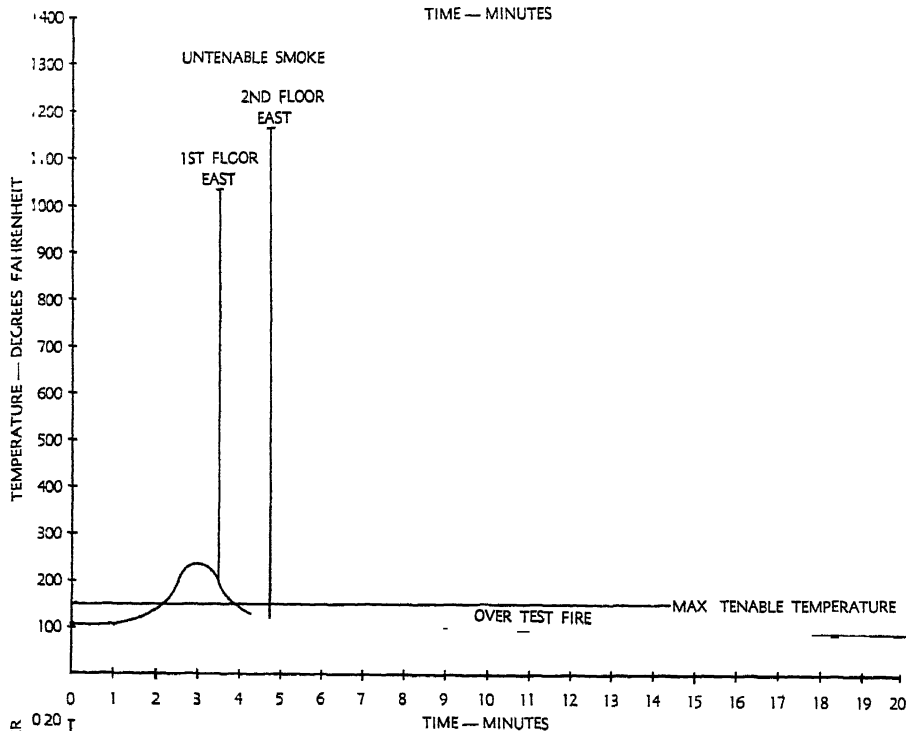
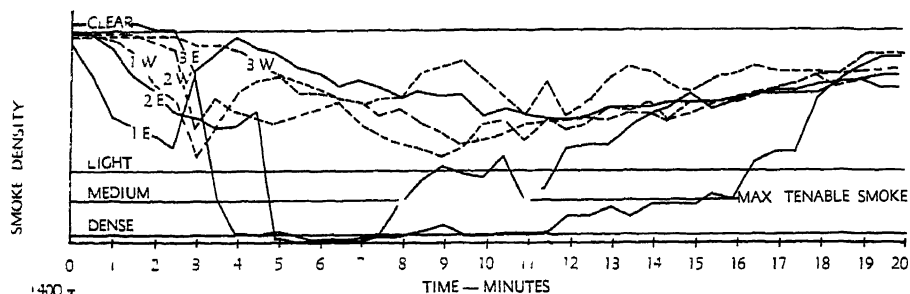
**Other:** Vent open at start of test fire. Sprinklers over test fire.  
Exit doors at west end of first floor corridor opened 30  
seconds after operation of first sprinkler.

**Comments:**

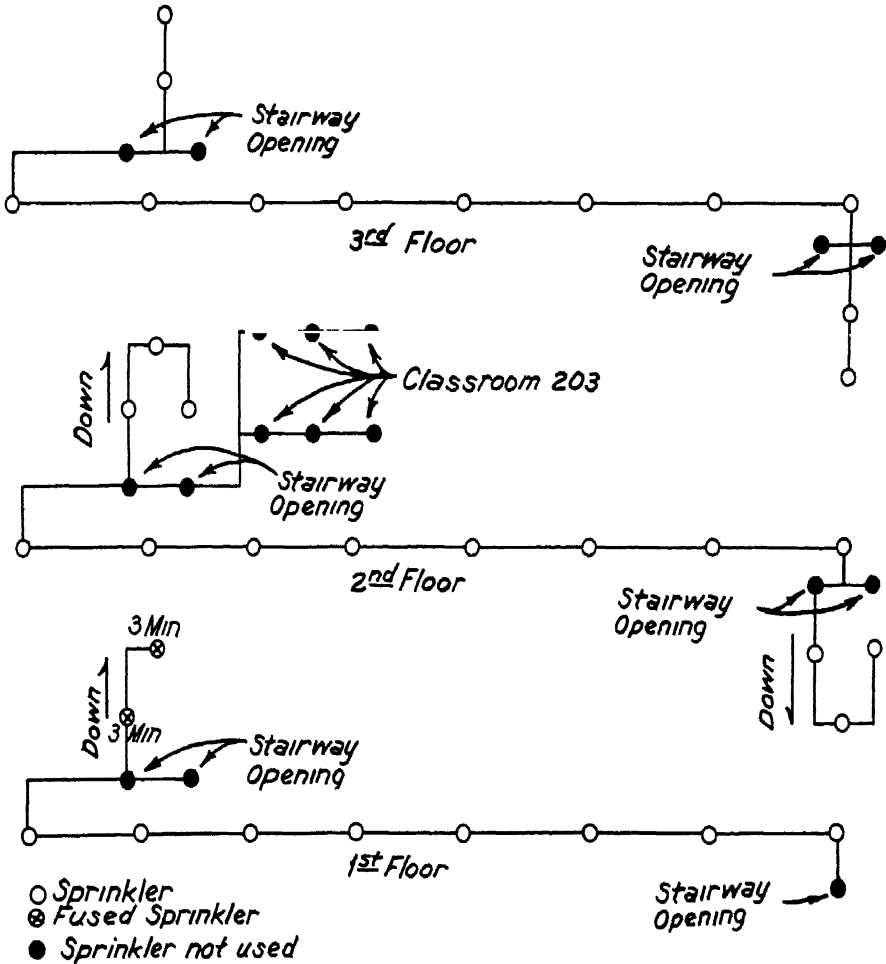
Only sprinklers over fire operated which controlled fire but did not completely extinguish it due to solid pallets in test fire

Only the east end of the first and second floor corridors reached untenable smoke conditions.

Vent action not satisfactory due to the fact that temperature differences were never sufficient to create effective stack action



## Automatic Sprinkler Operation



## Comments on Sprinkler Operation:

Sprinklers Utilized: corridors and stairways.

## Automatic Fire Detection System

Circuit No.	Area Covered	Response Time from Fire Start	
		Minutes	Seconds
1	1st Floor Corridor	2	12
2	2nd Floor Corridor	No response.	
3	3rd Floor Corridor	No response.	
4	Room 203	No response	
5	Stairway No 2	2	28
6	Stairway No 1	No response	

## Temperature and Pressure Readings

FIRST FLOOR								
Time Min- utes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11	12U	12L	13U	13L	14U	14L	
1	105	100	90	95	95	95	85	0.00
2	115	110	95	105	100	95	85	0.00
3	235	130	105	110	110	100	85	0.00
4	120	115	105	125	115	105	85	0.00
5	110	105	95	120	110	105	85	0.00
6	110	100	90	110	105	100	85	0.00
7	110	95	90	105	100	95	85	0.00
8	110	95	90	105	95	95	80	0.00
9	100	90	85	100	95	90	80	0.00
10	95	85	85	95	95	90	80	0.00
11	90	85	85	90	90	90	80	0.00
12	90	85	85	90	90	90	80	0.00
13	90	85	85	90	90	90	80	0.00
14	90	85	85	90	90	90	80	0.00
15	90	85	85	90	90	90	80	0.00
16	90	85	85	90	90	90	80	0.00
17	90	85	85	90	90	90	80	0.00
18	90	85	85	90	90	90	80	0.00
19	90	85	85	90	90	90	80	0.00
20	90	85	85	90	90	90	80	0.00

## Temperature and Pressure Readings

SECOND FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	21	22U	22L	23U	23L	24U	24L	25	
1	100	90	85	80	90	90	90	90	0.00
2	105	95	85	80	90	90	90	90	0.00
3	125	105	90	85	95	95	90	90	0.00
4	115	105	90	85	95	95	90	95	0.00
5	105	100	90	85	95	95	90	95	0.00
6	95	95	90	90	95	95	90	95	0.00
7	95	95	90	95	95	95	90	90	0.00
8	95	95	90	95	95	95	90	90	0.00
9	90	90	90	95	95	95	90	90	0.00
10	85	90	85	95	95	95	90	90	0.00
11	85	85	85	95	95	95	90	90	0.00
12	85	85	85	95	95	95	90	90	0.00
13	85	85	85	95	95	95	90	90	0.00
14	85	85	85	95	95	95	90	90	0.00
15	85	85	85	95	95	95	90	90	0.00
16	85	85	85	95	95	95	90	90	0.00
17	85	85	85	95	95	95	90	90	0.00
18	85	85	85	90	90	90	90	90	0.00
19	85	85	85	90	90	90	90	90	0.00
20	85	85	85	90	90	90	90	90	0.00

THIRD FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	31	32U	32L	33U	33L	34U	34L	35	
1	90	80	85	90	90	90	90	90	0.00
2	90	85	85	90	90	90	90	90	0.00
3	95	85	90	90	90	90	90	90	0.00
4	90	90	85	90	90	90	90	90	0.00
5	90	90	85	90	90	90	90	90	0.00
6	90	90	90	90	90	90	90	90	0.00
7	90	90	90	90	90	90	90	90	0.00
8	85	90	90	90	90	90	90	90	0.00
9	85	85	90	90	90	90	90	90	0.00
10	85	85	90	90	90	90	90	90	0.00
11	85	85	90	90	90	90	90	90	0.00
12	85	85	90	90	90	90	90	90	0.00
13	85	85	90	90	90	90	90	90	0.00
14	85	85	90	90	90	90	90	90	0.00
15	85	85	90	90	90	90	90	90	0.00
16	85	85	90	90	90	90	90	90	0.00
17	85	85	90	90	90	90	90	90	0.00
18	85	85	90	90	90	90	90	90	0.00
19	85	85	90	90	90	90	90	90	0.00
20	85	85	90	90	90	90	90	90	0.00

## Series K

### Sprinklers, Curtain Boards, and Forced Draft Vent

This series includes only three tests and these were conducted to study the effectiveness of automatic sprinklers, curtain boards and an aspirator installed in the vent opening at the top of stairway No. 2.

One test was conducted in a sprinklered classroom; one in an unsprinklered classroom, and one at the base of stairway No. 2.

#### Test K-1

**Date:** May 1, 1959

**Outdoor Temperature:** 71° F. **Humidity:** 55% **Wind:** 9.0 m p.h. SW Average

**Fuel:** 1,400 pounds of pallets

**Location of Test Fire:** Classroom No 103

**Automatic Sprinklers:** Corridors only

**Vents:** 40 square feet at top of stairway No 2

**Curtain Boards:** Corridors only

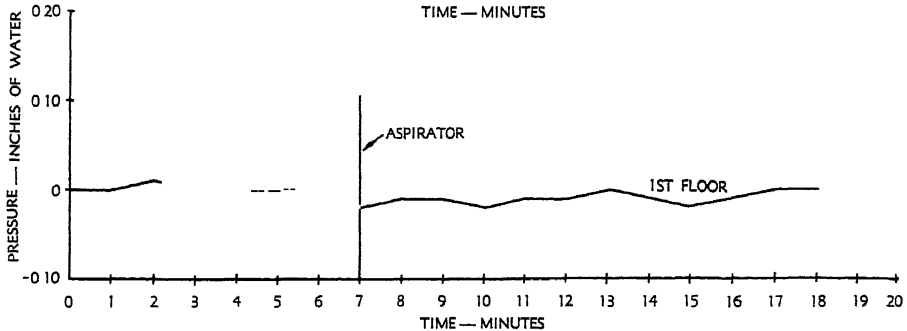
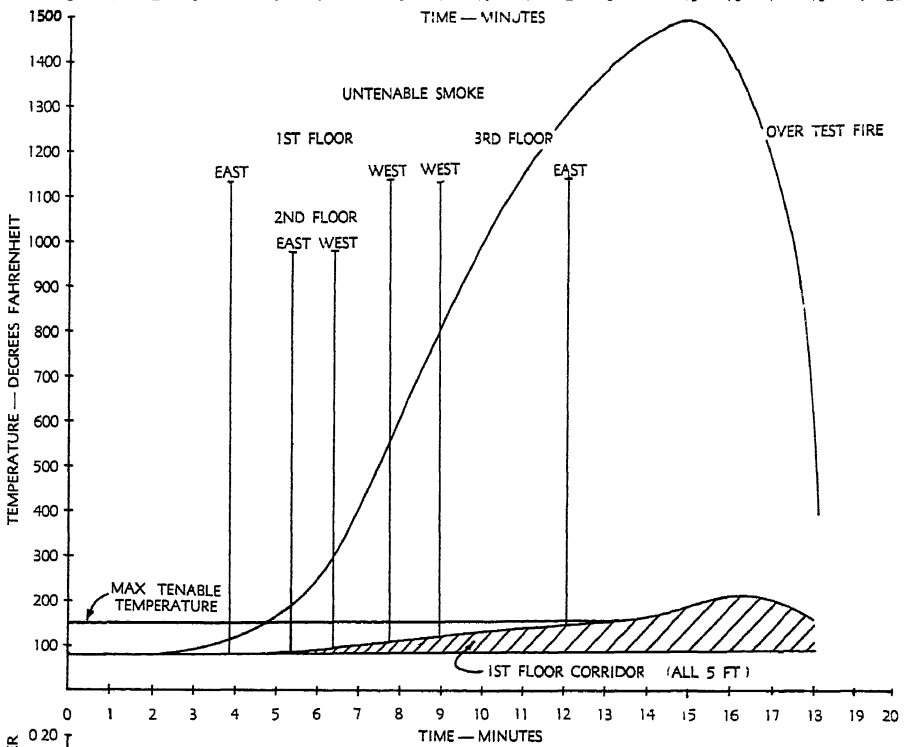
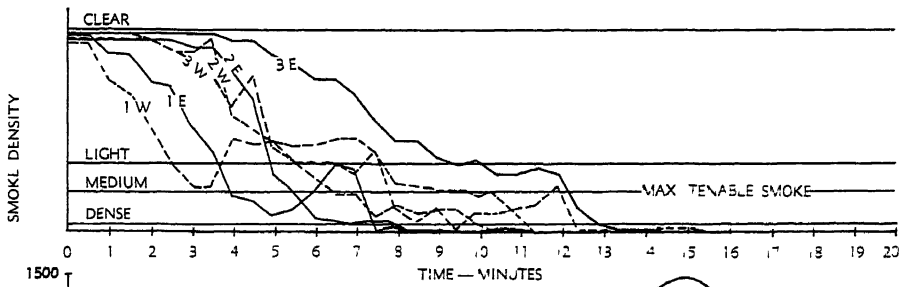
**Automatic Fire Detection:** None

**Other:** Aspirator installed in vent at top of stairway No. 2. Vent opened at fire start and aspirator started at operation of first sprinkler head. Four transoms between the corridor and classroom No. 103 open. Glass in exterior windows in classroom No. 103 broken from previous tests. No pressure readings taken in second and third floor corridors.

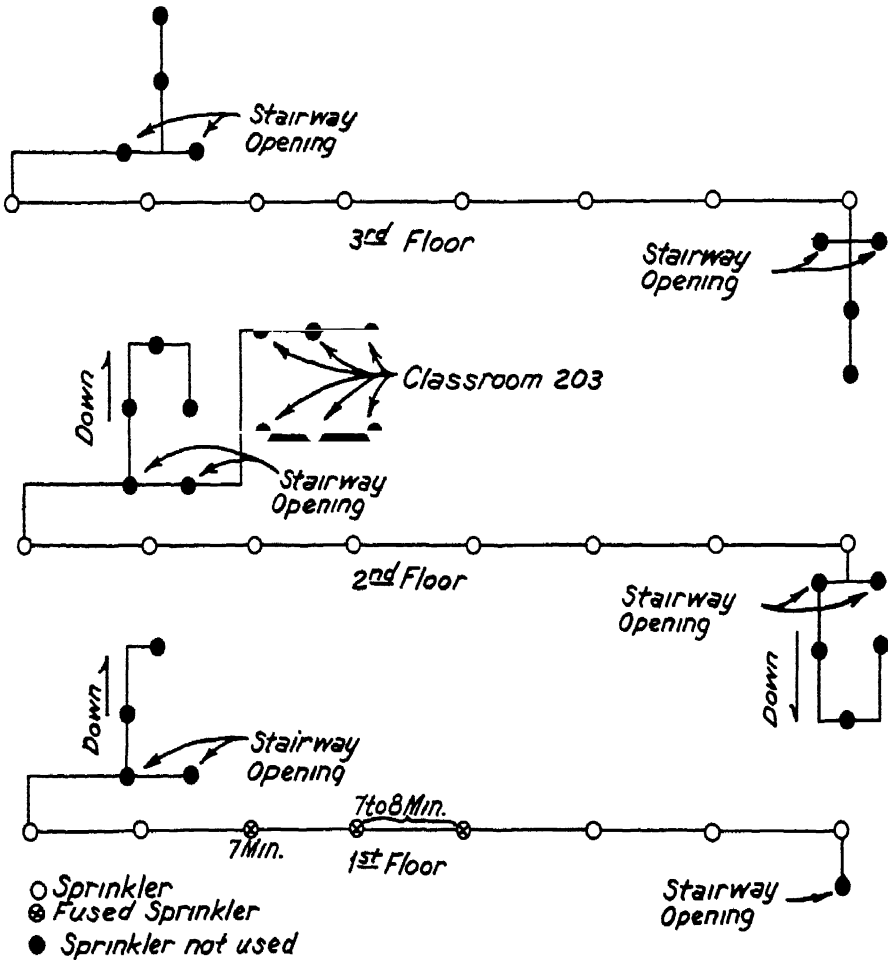
#### **Comments:**

Aspirator did not clear smoke from corridors.

Sprinklers kept temperatures down in the first floor corridor but the east end of the corridor was untenable from smoke in 4 minutes and the west end in 8 minutes



### Automatic Sprinkler Operation



#### Comments on Sprinkler Operation:

Sprinklers Utilized: corridors only.

## Temperature and Pressure Readings

FIRST FLOOR								
Time Minutes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11 *	12U	12L	13U	13L	14U	14L	
1	80	75	75	85	80	85	75	0.00
2	90	75	75	85	85	85	75	0.01
3	90	75	75	95	85	85	75	0.00
4	115	80	75	100	85	85	75	0.00
5	150	95	75	105	90	85	75	0.00
6	250	110	80	130	35	85	75	0.00
7	360	155	80	170	80	35	75	-0.02
8	530	125	90	130	110	100	75	-0.01
9	950	115	100	145	115	105	85	-0.01
10	1190	120	110	160	120	105	90	-0.02
11	1180	130	120	160	125	115	95	-0.01
12	1225	140	115	150	115	110	85	-0.01
13	1305	130	115	145	125	110	95	0.00
14	1315	135	110	125	120	120	95	-0.01
15	1505	155	115	170	140	110	90	-0.02
16	725	150	215	155	140	120	100	-0.01
17	330	135	210	150	125	115	95	0.00
18	400	120	105	130	125	120	90	0.00
19								
20								

\*Classroom 103

SECOND FLOOR								
Time Min- utes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	21	22U	22L	23U	23L	24U	24L	
1	75	75	75	80	80	80	80	80
2	75	75	75	80	80	85	80	85
3	75	75	75	80	80	80	80	80
4	75	75	75	80	80	80	80	80
5	85	80	75	80	80	80	80	80
6	95	85	75	80	85	85	85	85
7	125	90	80	85	85	85	85	85
8	105	95	80	90	90	90	85	95
9	100	95	85	95	90	85	85	100
10	110	100	90	100	100	90	85	95
11	120	110	90	100	100	95	90	100
12	125	110	100	110	110	100	90	100
13	115	105	100	115	115	110	95	105
14	120	105	100	110	110	105	100	110
15	130	115	105	110	110	105	100	110
16	130	125	115	125	115	120	105	110
17	130	120	105	120	120	115	100	115
18	115	110	105	115	115	115	100	110
19								
20								



## Test K-2

**Date:** May 1, 1959

**Outdoor Temperature:** 69° F. **Humidity:** 55% **Wind:** 9.0 m.p h SW Average

**Fuel:** 1,400 pounds of pallets with two inches of newspaper on top of stack

**Location of Test Fire:** Classroom No 203

**Automatic Sprinklers:** Corridors and classroom No. 203

**Vents:** 40 square feet at top of stairway No 2

**Curtain Boards:** Corridors only

**Automatic Fire Detection:** Coverage as shown in Figure 12

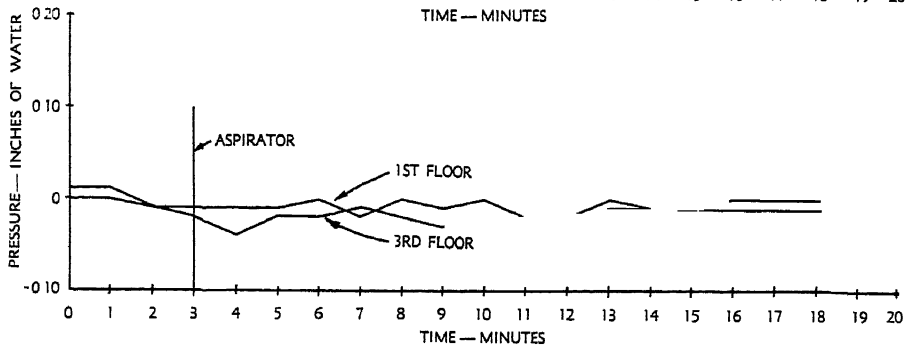
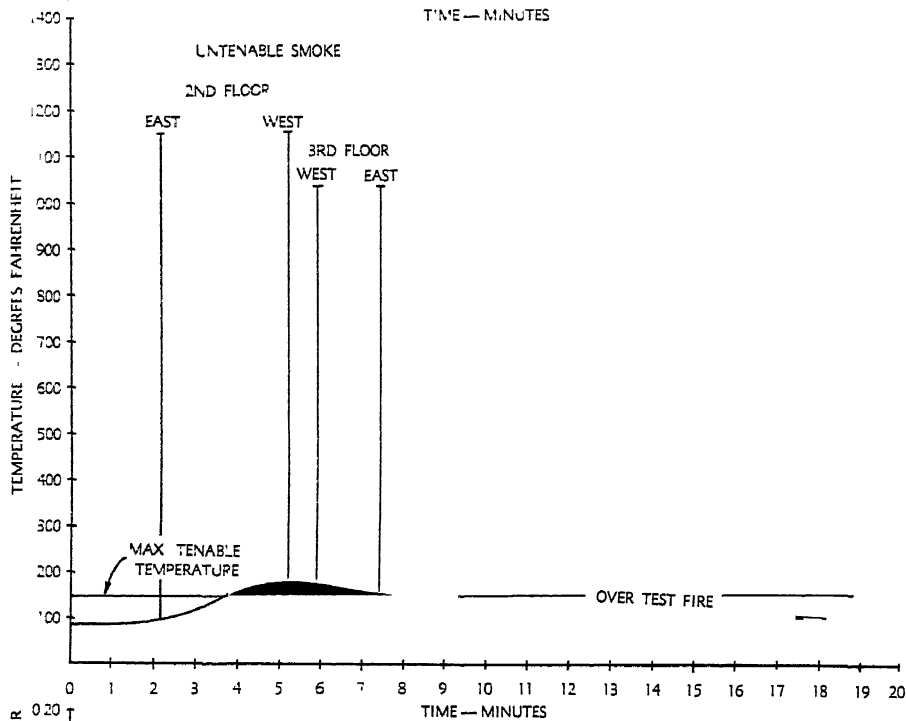
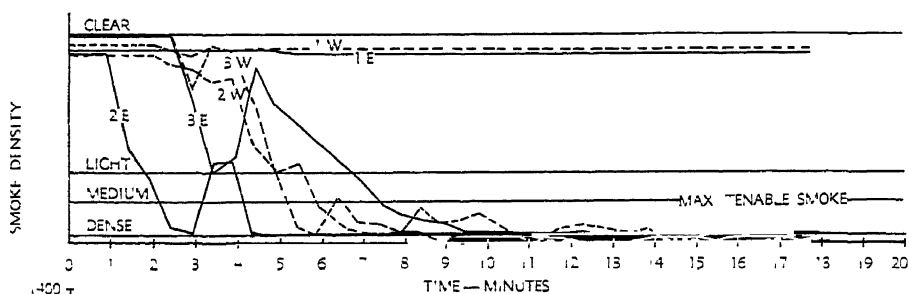
**Other:** Aspirator installed in vent at top of stairway No 2. Vent opened at fire start and aspirator started at operation of first sprinkler. Two exterior windows in classroom No 203 open one foot from the bottom and two transoms between that room and the corridor open. Exit doors at west end of first floor corridor opened 30 seconds after aspirator started. Back of enclosure around aspirator opened No pressure readings taken in second floor corridor.

### Comments:

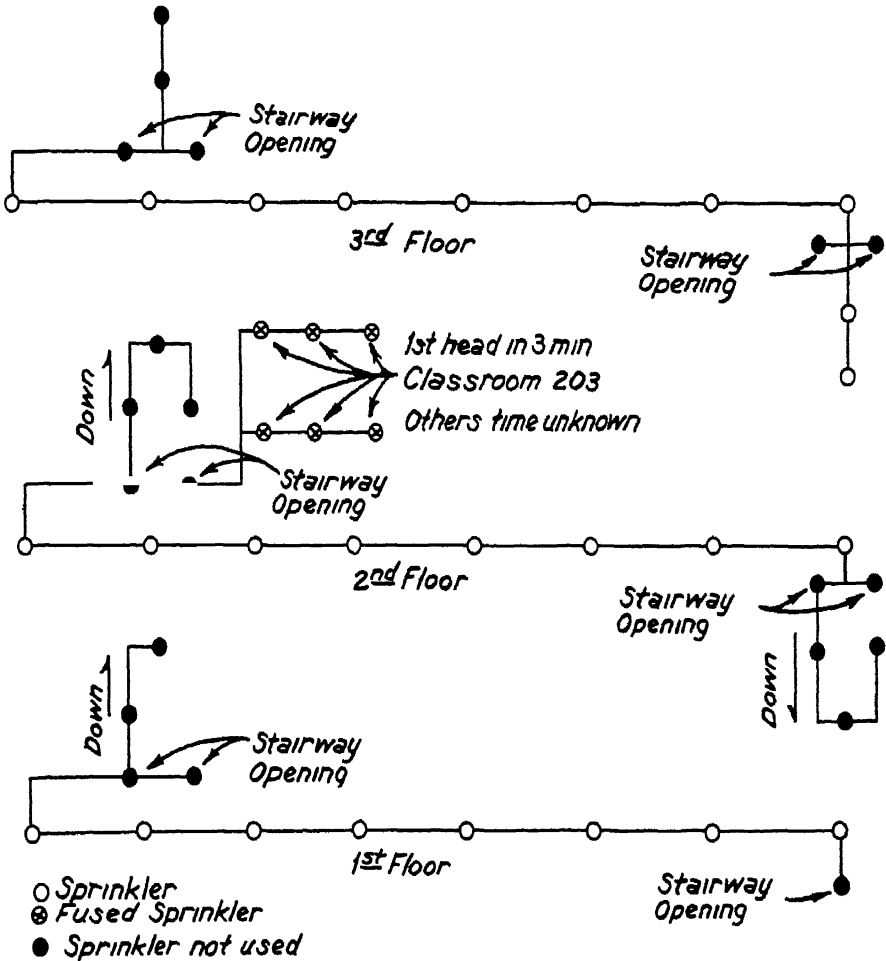
Second and third floor corridors became untenable from smoke

Aspirator failed to clear smoke from corridors.

Sprinklers in classroom No 203 held fire in check but did not extinguish it since it was shielded from sprinkler discharge with newspaper.



## Automatic Sprinkler Operation



## Comments on Sprinkler Operation:

Sprinklers Utilized: corridors and Room 203.

## Automatic Fire Detection System

Circuit No.	Area Covered	Response Time from Fire Start	
		Minutes	Seconds
1	1st Floor Corridor	Not used on this test.	
2	2nd Floor Corridor	3	5
3	3rd Floor Corridor	Not used on this test.	
4	Room 203	2	30
5	Stairway No. 2	Not used on this test.	
6	Stairway No. 1	Not used on this test.	

## Temperature and Pressure Readings

FIRST FLOOR								
Time Minutes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11*	12U	12L	13U	13L	14U	14L	
1	85	75	75	85	85	85	75	0.00
2	95	75	75	85	85	85	75	-0.01
3	105	75	75	85	85	85	75	-0.01
4	185	75	75	85	85	85	75	-0.01
5	185	75	75	85	85	85	75	-0.01
6	175	75	75	85	85	85	75	0.00
7	145	75	75	85	85	85	75	-0.02
8	125	75	75	85	85	85	75	0.00
9	125	75	75	85	85	85	75	-0.01
10	130	75	75	85	85	85	75	0.00
11	130	75	75	85	85	85	75	-0.02
12	150	75	75	85	85	85	75	-0.02
13	145	75	75	85	85	85	75	0.00
14	150	75	75	85	85	85	75	-0.01
15	130	75	75	85	85	85	75	-0.01
16	110	75	75	85	85	85	75	0.00
17	105	75	75	85	85	85	75	0.00
18	120	75	75	85	85	85	75	0.00
19								
20								

\*Classroom 203

## Temperature and Pressure Readings

[illegible][illegible]

### Test K-3

**Date:** April 30, 1959

**Outdoor Temperature:** 73° F   **Humidity:** 70%   **Wind:** 6.8  
m.p.h. W Average

**Fuel:** 1,400 pounds of pallets

**Location of Test Fire:** Base of stairway No. 2

**Automatic Sprinklers:** Corridors only

**Vents:** 40 square feet at top of stairway No. 2

**Curtain Boards:** Corridors only

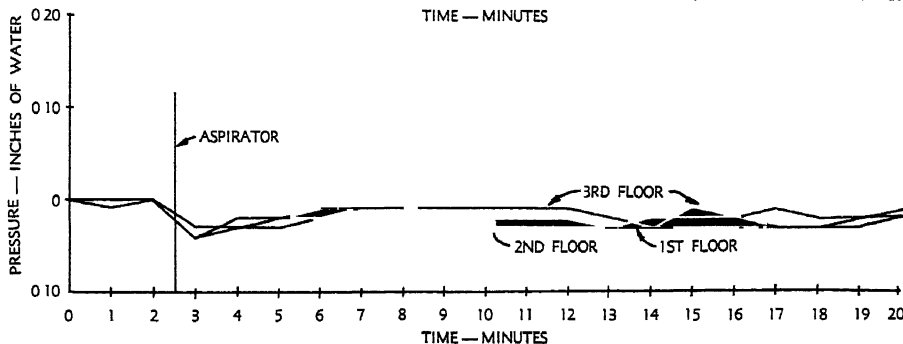
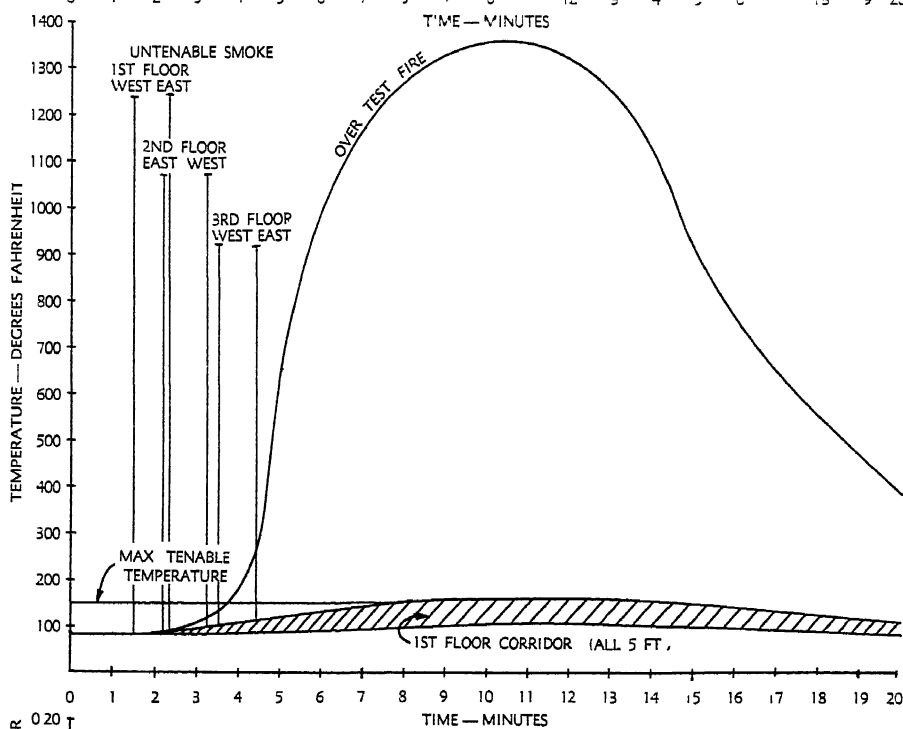
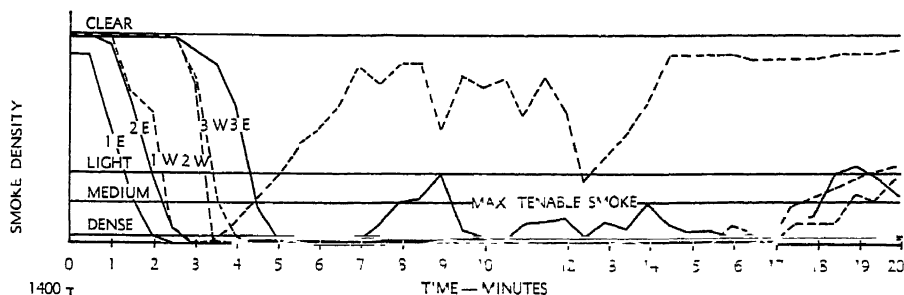
**Automatic Fire Detection:** Coverage as shown in Figure 12

**Other:** Aspirator installed in vent at top of stairway No. 2  
Vent open at fire start and aspirator started when signal  
received from automatic fire detection system circuit No. 5  
(2 minutes, 26 seconds) Exit doors at west end of first floor  
corridor opened 30 seconds after aspirator started Wire to  
thermocouple No. 21 broke at 12 minutes

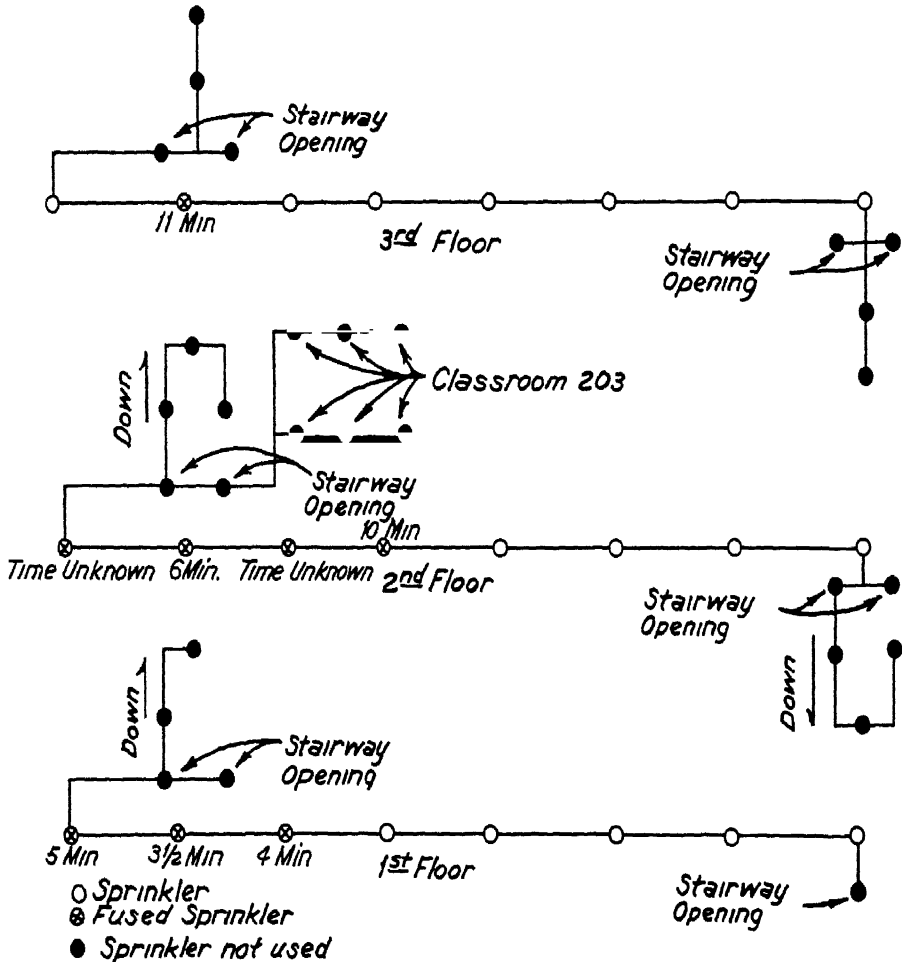
#### **Comments:**

Aspirator with exit doors opened cleared smoke from  
the west end of first floor corridor

Operating sprinklers kept temperatures down in cor-  
ridors.



## Automatic Sprinkler Operation



## Comments on Sprinkler Operation:

Sprinklers Utilized: corridors only

## Automatic Fire Detection System

Circuit No.	Area Covered	Response Time from Fire Start	
		Minutes	Seconds
1	1st Floor Corridor	2	50
2	2nd Floor Corridor	3	34
3	3rd Floor Corridor	3	48
4	Room 203	3	52
5	Stairway No 2	2	26
6	Stairway No 1	3	52

## Temperature and Pressure Readings

FIRST FLOOR								
Time Min- utes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11	12U	12L	13U	13L	14U	14L	
1	85	85	85	90	90	90	80	0.00
2	90	95	85	90	90	90	80	0.00
3	120	165	110	110	110	95	80	-0.04
4	170	200	125	110	150	110	105	-0.03
5	660	180	135	130	135	110	100	-0.03
6	900	185	140	155	120	105	100	-0.02
7	1180	200	135	145	115	100	95	-0.03
8	1300	245	140	150	130	105	95	-0.03
9	1310	255	145	150	120	105	100	-0.03
10	1390	285	145	155	135	120	100	-0.03
11	1320	280	150	155	135	110	100	-0.03
12	1310	265	150	155	130	110	100	-0.03
13	1235	250	145	155	130	105	100	-0.03
14	1100	225	145	150	115	110	100	-0.03
15	890	205	145	145	115	100	100	-0.03
16	745	225	135	140	115	100	95	-0.03
17	690	190	130	140	110	100	95	-0.03
18	610	165	120	130	115	100	95	-0.03
19	530	150	125	125	110	95	90	-0.03
20	380	95	100	120	105	95	90	-0.02

## Temperature and Pressure Readings

SECOND FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	21	22U	22L	23U	23L	24U	24L	25	
1	85	85	85	90	90	90	90	90	-0.01
2	95	85	85	90	90	90	90	90	0.00
3	175	95	85	90	90	90	90	95	-0.04
4	170	185	95	115	110	110	95	105	-0.02
5	175	190	125	145	140	135	100	100	-0.02
6	250	130	130	165	140	140	105	95	-0.01
7	325	145	135	170	140	140	105	90	-0.01
8	335	150	145	185	145	150	105	95	-0.01
9	350	150	145	170	150	155	110	95	-0.02
10	480	140	165	125	135	135	115	105	-0.02
11	515	140	155	120	130	130	120	110	-0.02
12		140	170	130	130	130	110	105	-0.02
13		135	165	125	130	125	110	100	-0.03
14		135	165	120	125	120	105	100	-0.02
15		125	150	115	120	115	105	90	-0.02
16		120	140	115	120	115	105	95	-0.02
17		120	130	115	115	115	105	95	-0.03
18		115	125	110	110	110	105	90	-0.03
19		110	115	105	105	105	105	95	-0.02
20		110	110	100	100	105	105	90	-0.01

THIRD FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	31	32U	32L	33U	33L	34U	34L	35	
1	85	85	90	90	90	90	90	90	-0.01
2	85	85	90	90	90	90	90	90	0.00
3	90	85	90	90	90	90	90	90	-0.03
4	105	85	90	90	90	90	90	110	-0.03
5	145	90	95	100	95	105	100	110	-0.02
6	160	120	105	105	105	115	110	120	-0.02
7	180	140	110	110	110	120	110	120	-0.01
8	220	165	120	115	110	120	115	130	-0.01
9	190	180	120	120	120	130	120	130	-0.01
10	215	190	125	120	120	125	120	125	-0.01
11	195	195	130	120	120	120	120	120	-0.01
12	125	140	120	120	120	120	120	120	-0.01
13	125	125	110	110	110	110	110	110	-0.02
14	125	125	115	115	110	115	110	115	-0.03
15	120	120	110	110	110	110	105	110	-0.01
16	115	105	110	110	110	110	105	110	-0.02
17	110	100	110	110	105	110	105	110	-0.01
18	105	95	105	105	105	105	105	105	-0.02
19	100	95	100	105	105	105	100	105	-0.02
20	100	95	100	100	105	100	100	105	-0.02

## Series L

### Acoustical Tile

During the first test with the test fire at the base of stairway No. 2, the cellulose fiber acoustical tile on the ceiling of the first floor corridor ignited and flashed full length of the corridor. This condition on acoustical tile rated as "Class C or slow burning" under U. S. Federal Specification SS-A-118b, prompted two more tests of the flame spread on similar "slow burning" cellulose fiber acoustical tile and one test in which the tile was painted with an Underwriters' Laboratories listed fire retardant paint.

#### Test L-1

**Date:** May 4, 1959

**Outdoor Temperature:** 67° F. **Humidity:** 38% **Wind:** 6.8 m.p.h. W Average

**Fuel:** 1,400 pounds of pallets

**Location of Test Fire:** On landing between basement and first floor in stairway No. 2

**Automatic Sprinklers:** None

**Vents:** 21 square feet at top of stairway No. 2

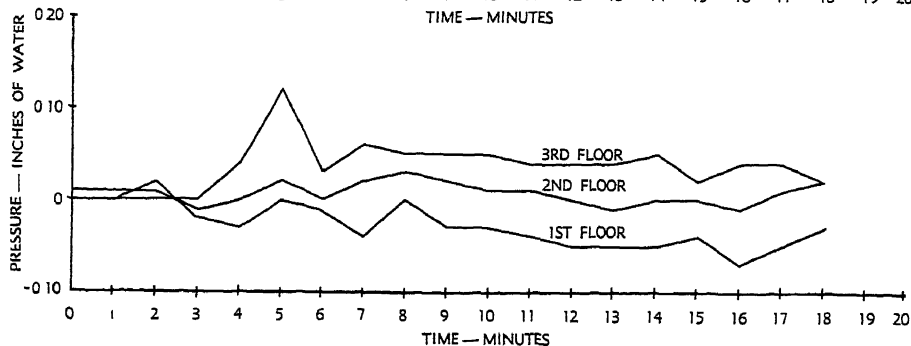
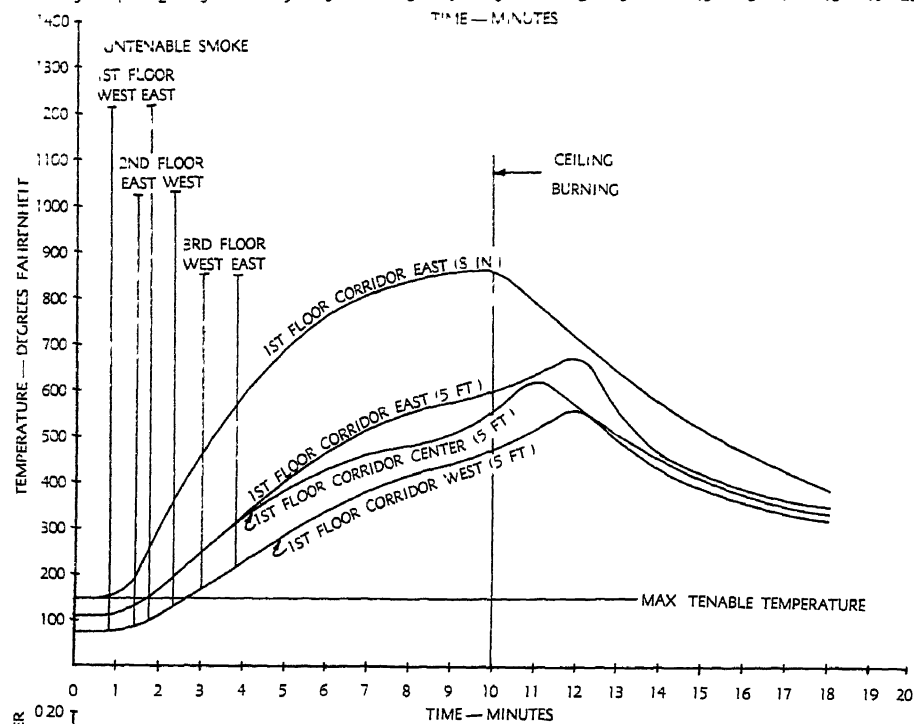
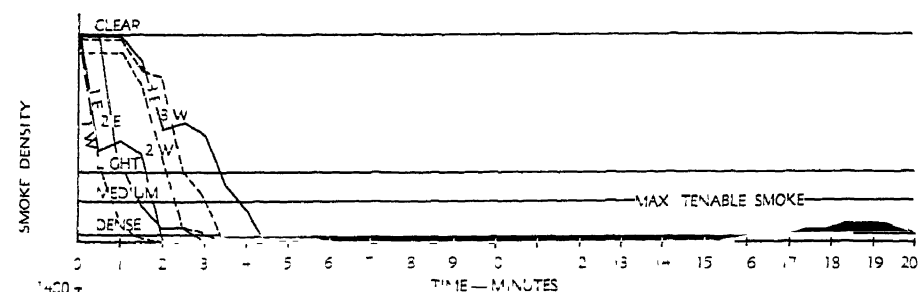
**Curtain Boards:** Second and third floor corridors only

**Automatic Fire Detection:** Coverage as shown in Figure 12 and directly over test fire

**Other:** Ceiling of first floor corridor covered with cellulose fiber acoustical tile on wood strapping. Vent open at start of test fire. Thermocouple No. 11 not used.

#### Comments:

Ceiling ignited 10 minutes after start of test fire and flashed full length of first floor corridor.



## Automatic Fire Detection System

Circuit No.	Area Covered	Response Time from Fire Start	
		Minutes	Seconds
1	1st Floor Corridor	0	40
2	2nd Floor Corridor	1	35
3	3rd Floor Corridor	2	40
4	Room 203	1	55
5	Stairway No 2	0	30
6	Stairway No 1	1	25

## Temperature and Pressure Readings

FIRST FLOOR								
Time Min- utes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11	12U	12L	13U	13L	14U	14L	
1		150	80	145	110	110	75	0.00
2		330	165	195	170	150	110	0.02
3		475	270	310	265	255	160	-0.02
4		610	355	405	340	350	205	-0.03
5		650	325	470	390	410	255	0.00
6		720	440	515	425	455	340	-0.01
7		800	525	555	465	490	380	-0.04
8		840	550	580	480	575	410	0.00
9		860	570	590	480	525	425	-0.03
10		870	585	605	485	540	440	-0.03
11		805	640	835	620	665	500	-0.04
12		670	620	745	570	710	560	-0.05
13		600	480	560	400	545	465	-0.05
14		590	470	515	450	490	420	-0.05
15		500	430	470	415	450	390	-0.04
16		475	400	450	410	430	375	-0.07
17		405	365	415	350	400	335	-0.05
18		385	355	375	335	365	315	-0.03
19								
20								

## Temperature and Pressure Readings

[illegible][illegible]

## Test L-2

**Date:** May 7, 1959

**Outdoor Temperature:** 78° F   **Humidity:** 51%   **Wind:** 5.6  
m p h   W Average

**Fuel:** 1,400 pounds of pallets

**Location of Test Fire:** On landing between basement and first  
floor in stairway No 2

**Automatic Sprinklers:** None

**Vents:** 21 square feet at top of stairway No. 2

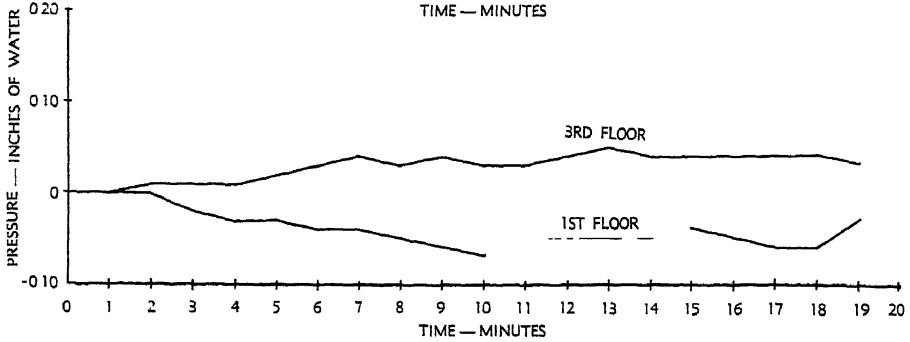
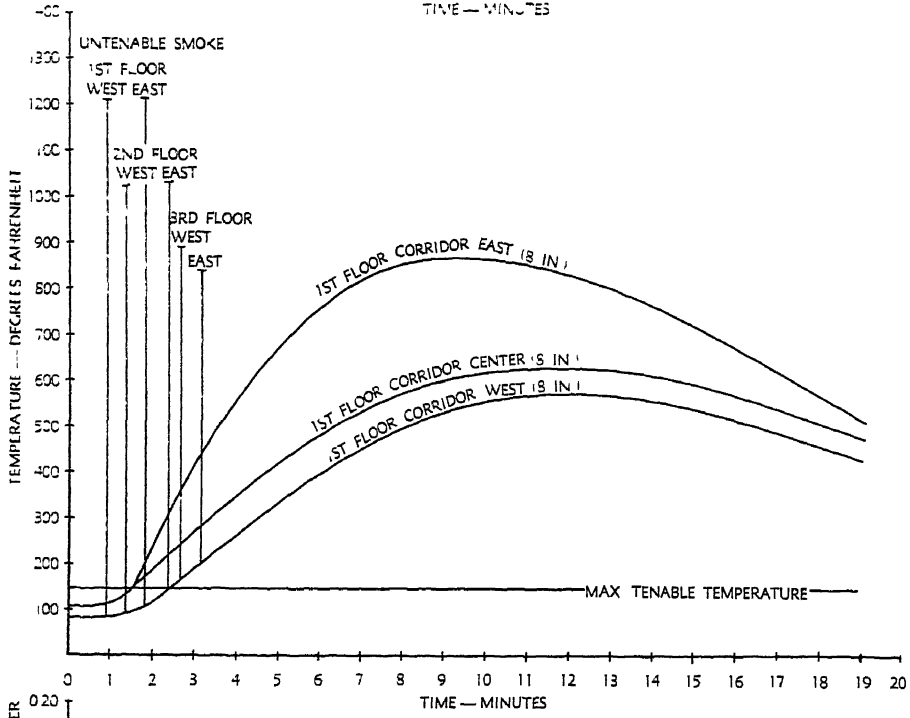
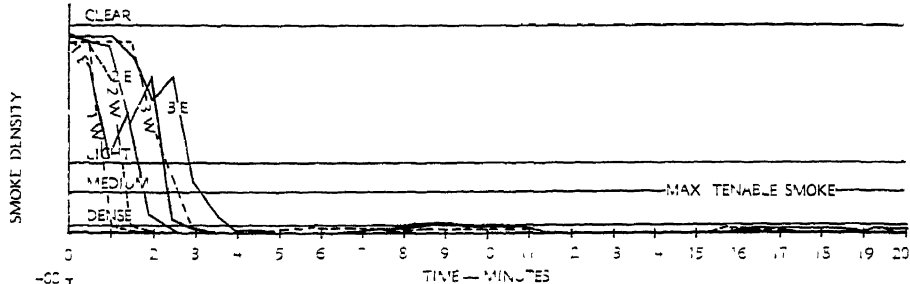
**Curtain Boards:** None

**Automatic Fire Detection:** None

**Other:** Ceiling of first floor corridor covered with cellulose fiber  
acoustical tile on wood strapping. From the center to the  
east end of the corridor the tile was painted with a fire  
retardant paint Vent open at start of test fire. No pressure  
readings taken in second floor corridor. Thermocouple  
No 11 not used.

### Comments:

Small blue flames around area where flame from test  
fire impinged on the ceiling but there was no propagation of  
flame on the ceiling tile



## Temperature and Pressure Readings

FIRST FLOOR								
Time Minutes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11	12U	12L	13U	13L	14U	14L	
1		105	80	90	95	85	80	0.00
2		285	85	200	215	130	80	0.00
3		325	125	270	255	210	100	-0.02
4		420	200	305	300	240	105	-0.03
5		755	330	365	430	305	220	-0.03
6		775	445	495	505	410	310	-0.04
7		830	525	560	610	485	400	-0.04
8		865	575	580	635	575	425	-0.05
9		850	600	605	660	540	455	-0.06
10		835	625	615	660	555	465	-0.07
11		845	625	640	775	560	470	-0.05
12		830	620	650	820	570	475	-0.05
13		835	600	640	715	575	460	-0.05
14		640	525	605	625	550	460	-0.05
15		645	565	580	640	525	445	-0.04
16		610	535	545	605	505	425	-0.05
17		555	515	525	575	480	405	-0.06
18		575	530	500	555	455	390	-0.06
19		510	515	485	535	445	370	-0.03
20								

SECOND FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	21	22U	22L	23U	23L	24U	24L	25	
1	85	85	75	85	85	85	85	85	
2	140	125	80	115	85	120	90	145	
3	220	180	90	155	110	170	110	190	
4	280	225	110	170	120	185	125	215	
5	395	295	145	220	150	240	155	230	
6	470	345	180	270	195	315	200	360	
7	515	380	225	310	245	370	235	415	
8	525	390	250	325	275	380	265	400	
9	545	415	260	340	295	400	285	460	
10	545	410	265	350	305	410	300	465	
11	580	455	280	370	315	405	310	475	
12	605	470	305	385	315	410	320	485	
13	595	470	310	385	325	410	335	485	
14	585	495	320	390	325	385	340	460	
15	525	420	310	370	335	395	335	450	
16	585	395	295	350	320	395	320	430	
17	455	375	290	335	310	385	310	415	
18	430	360	285	315	300	370	300	400	
19	410	340	270	310	295	350	295	385	
20									



**Test L-3**

**Date:** May 7, 1959

**Outdoor Temperature:** 74° F   **Humidity:** 51%   **Wind:** 5.6  
m.p.h. W Average

**Fuel:** 500 pounds of pallets

**Location of Test Fire:** At west end of first floor corridor

**Automatic Sprinklers:** None

**Vents:** 42 square feet at top of stairway No. 2; 42 square feet at  
top of stairway No. 1

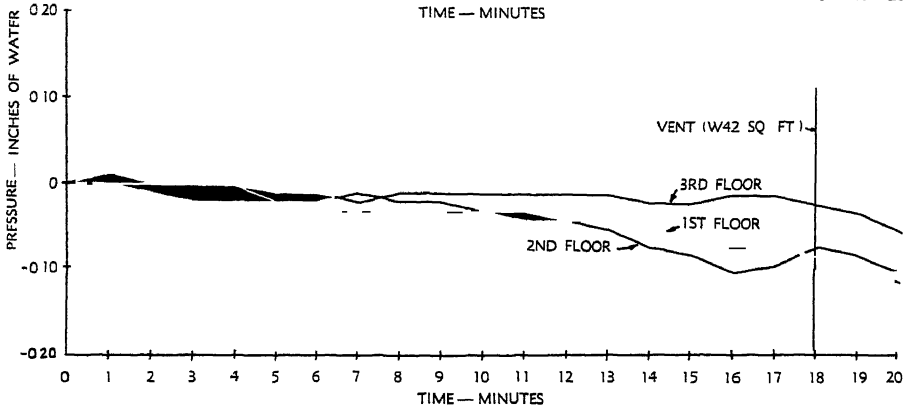
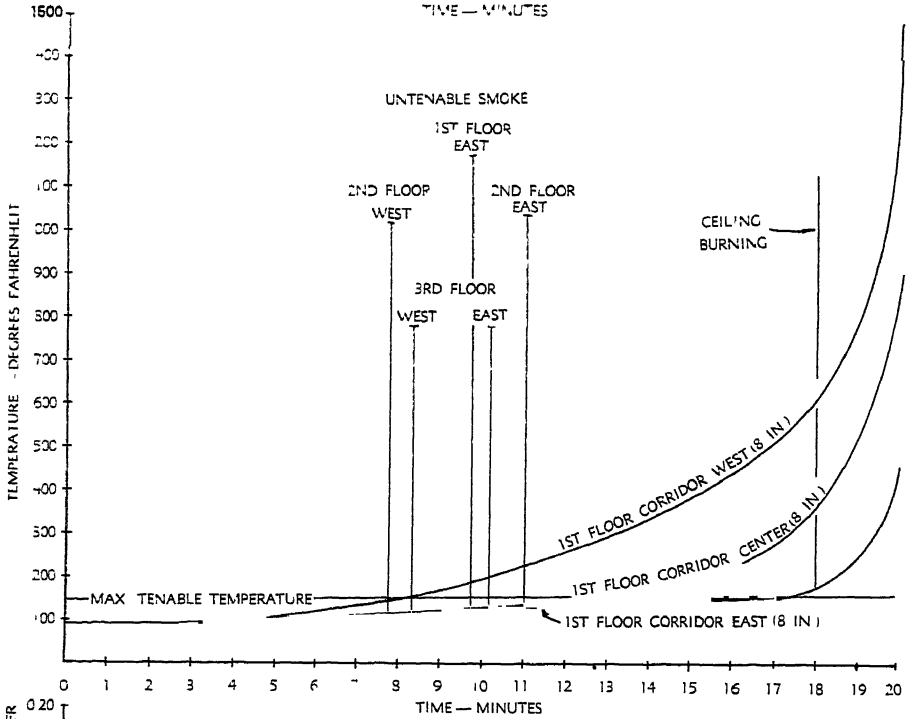
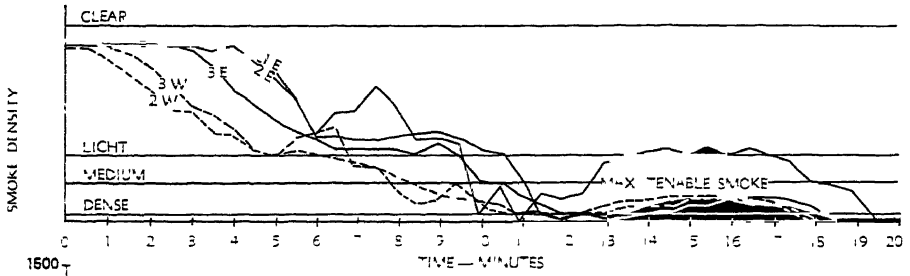
**Curtain Boards:** None

**Automatic Fire Detection:** None

**Other:** Ceiling of first floor corridor covered with cellulose fiber  
acoustical tile on wood strapping. East half of the corridor  
ceiling tile painted with fire retardant paint and exposed to  
test fire L-2. East vent open at start of test fire. West vent  
opened when ceiling ignited. No smoke density readings  
taken at west end of first floor corridor. Thermocouple  
No. 11 not used.

**Comments:**

Ceiling tile ignited 18 minutes after start of test fire  
and flashed entire length of unpainted portion of ceiling.



## Temperature and Pressure Readings

FIRST FLOOR								
Time Min- utes	Temperature-Degrees Fahrenheit							Pressure Inches of Water
	Thermocouple Location							
	11	12U	12L	13U	13L	14U	14L	
1		85	85	95	95	95	85	0.00
2		90	90	95	95	105	105	-0.01
3		90	90	100	100	110	110	-0.02
4		90	90	110	105	120	140	-0.02
5		100	90	115	110	130	145	-0.02
6		110	100	120	110	135	125	-0.03
7		110	100	130	110	130	110	-0.03
8		105	95	115	110	120	105	-0.03
9		105	100	115	105	115	105	-0.03
10		115	100	125	115	120	105	-0.03
11		160	110	185	135	210	145	-0.03
12		210	120	245	165	285	190	-0.04
13		230	130	270	175	315	195	-0.04
14		255	130	325	195	375	215	-0.05
15		285	135	335	210	390	240	-0.06
16		310	145	380	235	440	275	-0.07
17		335	160	430	260	500	295	-0.07
18		385	160	495	305	580	325	-0.08
19		550	195	985	525	1120	450	-0.09
20		995	450	1170	910	1485	1125	-0.11

SECOND FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	21	22U	22L	23U	23L	24U	24L	25	
1	70	85	80	95	95	95	95	95	0.00
2	95	90	85	95	95	95	95	95	0.00
3	95	90	90	95	95	100	95	100	0.00
4	95	90	90	100	95	105	95	110	0.00
5	100	90	90	105	95	110	100	115	-0.02
6	105	100	90	105	95	110	100	115	-0.02
7	110	100	90	105	100	110	100	115	-0.01
8	105	100	90	105	100	110	100	110	-0.02
9	105	100	90	100	100	105	95	110	-0.02
10	105	100	90	100	100	110	100	120	-0.03
11	125	105	90	120	100	140	100	170	-0.04
12	165	145	100	145	105	175	105	205	-0.04
13	185	155	110	155	125	190	115	220	-0.05
14	200	165	120	175	130	215	125	250	-0.07
15	225	185	125	180	140	220	130	260	-0.08
16	250	200	135	190	150	240	140	285	-0.10
17	265	215	145	200	160	260	150	315	-0.09
18	295	230	155	215	170	285	160	355	-0.07
19	350	275	170	310	195	480	195	730	-0.08
20	535	420	230	465	250	640	270	805	-0.10

## Temperature and Pressure Readings

THIRD FLOOR									
Time Min- utes	Temperature-Degrees Fahrenheit								Pressure Inches of Water
	Thermocouple Location								
	31	32U	32L	33U	33L	34U	34L	35	
1	85	85	95	95	95	95	95	95	0.01
2	85	85	95	95	95	95	95	95	0.00
3	90	90	95	95	95	95	95	95	0.00
4	90	90	95	95	95	95	95	95	0.00
5	90	90	95	95	95	95	95	100	-0.01
6	90	90	95	95	95	95	95	100	-0.01
7	90	90	95	100	100	100	100	105	-0.02
8	90	90	95	100	100	100	100	105	-0.01
9	90	90	95	100	100	100	100	100	-0.01
10	90	90	95	100	100	100	100	105	-0.01
11	95	95	100	100	100	105	100	110	-0.01
12	95	100	100	105	105	120	110	125	-0.01
13	100	105	105	115	110	130	120	140	-0.01
14	110	115	115	125	115	145	135	150	-0.02
15	120	125	115	140	125	150	145	160	-0.02
16	130	135	125	140	135	165	150	170	-0.01
17	135	140	135	150	145	175	160	180	-0.01
18	145	150	140	160	155	190	170	195	-0.02
19	155	165	150	175	165	210	185	235	-0.03
20	190	210	170	235	200	310	225	320	-0.05

## APPENDIX

### Additional Smoke Detector Tests

During the three-day period, June 28-30, six tests were conducted that were not part of the series in this report. These tests, however, included the installation of ionization type smoke detectors and the operation of the detectors is significant to the contents of this report

Since stairway No. 2 had been structurally damaged by previous test fires, the fires for these six tests were started at the west end of the first floor corridor. Fuel for each fire consisted of 1,400 pounds of wood pallets.

Ionization type smoke detectors were installed in the test building. On the second and third floors there were two detectors installed in the center of the corridor, one 20 feet from each end. On the first floor there was a detector installed in the center of the corridor 20 feet from the east end

At the time these tests were conducted, the equipment for measuring smoke density had been removed from the building. However, smoke and heat conditions within the test building were similar to those in other tests. The time of actuation of the ionization type smoke detectors in each of these tests is tabulated below

#### Actuation Time of Ionization Type Smoke Detectors

Test No.	1st Floor Corridor		2nd Floor Corridor		3rd Floor Corridor	
	Minutes	Seconds	Minutes	Seconds	Minutes	Seconds
1	1	20	No response.		No response.	
2	1	0	1	30	3	15
3	1	28	1	20	2	20
4	2	20	1	20	2	30
5	1	45	2	10	3	5
6	1	5	1	40	2	20







